THURSDAY, DECEMBER 24, 1914.

ROGER BACON AND GALILEO.

(1) *The Life and Work of Roger Bacon.* An Introduction to the Opus Majus. By J. H. Bridges. Pp. 173. (London: Williams and Norgate, 1914.) Price 3*s.* net.

(2) *Roger Bacon.* Essays contributed by Various Writers on the Occasion of the Commemoration of the Seventh Centenary of his Birth. Collected and edited by A. G. Little. Pp. viii+426. (Oxford: Clarendon Press, 1914.) Price 16*s.* net.

(3) *Dialogues Concerning Two New Sciences.* By Galileo Galilei. Translated from the Italian and Latin into English by Henry Crew and Alfonso De Salvio. Pp. xxi+300. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1914.) Price 8*s.* 6*d.* net.

THE seventh centenary of Roger Bacon's birth has been happily signalised by the republication in a separate handy volume (1) of the admirable "Life and Work" which the late Dr. Bridges prefixed to his edition of the "Opus Majus"; and by the issue from the Clarendon Press of a collection of essays (2) by eminent specialists, British and foreign, dealing with the different aspects of Bacon's work. To this volume the editor, Mr. A. G. Little, contributes an introductory life, valuable both for its own sake and because the author quotes at length a lucid and judicial estimate of Bacon from a lecture by the late Prof. Adamson.

Dr. Bridges's volume is, perhaps, the best estimate in short compass of Bacon's work and significance. The Oxford essayists follow practically the same order of topics, but treat them in greater detail;—Bacon's indebtedness to Robert Grosseteste (Dr. Baur), his relation to thirteenth century philosophy (M. Picavet), to philology (Dr. Hirsch), the Latin Vulgate (Cardinal Gasquet), mathematics (Prof. Eugene Smith), optics (Prof. E. Wiedemann), alchemy (Mr. Pattison Muir), medicine (E. Withington). Dr. Vogl discusses Bacon's curious theory of the transmission of force in the "De Multiplicatione Specierum"; Prof. Duhem shows wit as well as learning in his amusing history of the principle that nature abhors a vacuum; and Colonel Hime deduces from the ninth, tenth, and eleventh chapters of the "Epistola de Secretis Operibus," unintelligible as they stand, the complete Waltham Abbey formulæ for the refinement of saltpetre and manufacture of gunpowder, by methods which must delight the Shakespeare-Baconians or the admirers of Poe's "Gold Bug."

It is easy to exaggerate Bacon's actual achievements. These masterly essays leave the impression that he made few, if any, positive additions to science. "He gives no evidence of his own proficiency in calculation, nor does he show any conception of the nature of algebra." In geometry "he distinguishes between axioms, postulates, and definitions . . . but he makes no attempt to advance the science or to prove a single theorem." One-fifth of the "Opus Majus" is devoted to optics, but apparently he did little more than reproduce the Arabian tradition through Alhazen, with references to the Greek school of Euclid and Ptolemy. Though he quotes from Philo of Byzantium and Hero of Alexandria the classical experiments of the "chantepleure" and the adhesion discs, he argues the question of the vacuum as a pure Aristotelian and accepts without trial the supposed experimental fact that no power on earth would suffice to lift an inverted glass out of a bucket of water without first tilting the edge to admit air. "On aime à faire de Roger Bacon un adepte précoce de la méthode expérimentale; des pages comme celles-ci nous montrent assez qu'il expérimentait seulement en imagination." It does not do to read into his doctrine of the "Multiplication of Species" a forecast of the wave-propagation of light through the æther; or into the famous passage where he seems to anticipate the steam engine, the aeroplane, and the submarine more than a conviction, quite remarkable for his day, that the proper study of nature would work miracles in the service of man.

Bacon's greatness rests on other grounds. A good Catholic, he was yet of the pestilent class of innovators. He attacked authority. His strong character and original mind set about shaking itself free from the "horse-load" of verbal controversies that filled the schools of his day. He was no mathematician and not much of an experimenter; but it is his immortal glory that he was the first to state explicitly the true method of science, the union on equal terms of mathematics and experiment, with deeper insight than his great namesake who, three hundred years later, thought only of experiment and classification, ignoring the use of deduction. He urged the study of languages and philology in order to provide accurate texts of the Bible and Aristotle, denouncing in unmeasured terms the vices and luxury of the clergy, the stupidity of the philosophers content with their barren summaries and versions by those who knew neither the language of their authors nor the subjects they wrote about. He even dared to find many of the Christian virtues among the wise men of Arabia and the East, and valuable stores of knowledge unknown

to Aristotle. It was the aim of his life to sweep all this intellectual treasure house into the service of the church.

"He was aiming at an enlarged and renovated Catholicism," says Dr. Bridges, "which should bind together and incorporate all that was best and noblest in Hebrew, Greek, and Arabic tradition in the fabric of the Christian Church, for the spiritual government of the world. The keystone of the fabric was supplied by the mistress-science, theology, resting on Mosaic and Christian revelation, consolidated by Aristotelian philosophy, and penetrated by the vital and progressive spirit of natural science."

Profs. Crew and de Salvio have done a great service in their admirable translation (3) of Galileo's less-known dialogues, "Concerning Two New Sciences," *i.e.* strength of materials and dynamics. For though it is Galileo's astronomical work, with its dramatic consequences to himself, which sticks in the popular imagination, he stands among the greatest of the pioneers rather by reason of his advances in mechanics. He was the founder of modern physics, the first to put in practice the method urged by Roger Bacon, where mathematics and experiment go hand in hand.

This book should be in the hands of all teachers and, better still, of all students of mechanics. In the cut and dried text-book, the science leaps to birth full-armed in its panoply of dry propositions; but here we see it emerging step by step at the touch of genius from the very problems of practical life from which it took its rise, and the gain in reality is beyond belief. These are real dialogues, between Salviati, who represents Galileo's views, Sagredo, a wit and scholar, and Simplicio, an Aristotelian philosopher. The conversations are natural, discursive, yet closely reasoned. The Aristotelians are given more than fair play, for Galileo puts into Simplicio's mouth better arguments than they had advanced themselves. The inimitable style, with its lucid simplicity, its flashes of humour and sarcasm, gives the same instant impression of modernity that one gets on dipping after a long interval into one of Plato's dialogues. It loses nothing in the translation, where occasional racy Americanisms—"on time," "cuts no figure," "cut loose from"—seem quite in place.

The lapse of three hundred years is vividly realised in passing from Roger Bacon's scholastic Latin to these conversations that might have appeared in a modern review; from the dim, though explicit, formulation of the true method to its full and easy employment. Here is complete mathematical equipment (of the time) and every deductive conclusion is instantly put to the test of experiment. And surely the experiments are among the simplest and most truly elegant of all time. The guess that the speed acquired by bodies falling down inclined planes between two fixed horizontal levels is the same for all slopes and just sufficient to carry them to the original level *up any slope* (for otherwise a body might be made to lift itself unaided above its level) is tested by the most beautiful experiment of all—where the pendulum is set swinging and when the string is intercepted by a nail fixed at any height, the bob is found always to rise to the same level whatever circle it is compelled to pursue. Here, too, is the immediate inference of the First Law of Motion. For if the slope up which the body travels towards its original level is gradually reduced to the horizontal, *it will never get there*, and will therefore go on for ever, being now under the action of no forces!

There follows the famous discussion of falling bodies. The change of the point of view is at once apparent when the fruitless question *why* they fall is set aside until it is found *how* they fall. Simplicio suggests the natural view that the speed acquired is proportional to the distance fallen. But this is shown to be an impossible form of motion, since it implies that it takes as long to fall an inch as a mile. Is it then proportional to the time? In that case it is shown that the distance is proportional to the square of the time; and this is verified by the experiment of the inclined plane and water-clock. One wonders whether most to admire the theoretical insight or the experimental skill. Gravity, therefore, adds equal speeds in every second, however fast the body is moving. This is at once extended to the case of a body projected *across* gravity, horizontally, and the whole theory of the parabolic path of a projectile is deduced. The dialogues are full of interesting digressions, *e.g.* on various orders of infinity (worthy of modern transcendentalists), terminal velocities, brachistochrones, vibrations of stretched strings, the theory of harmony and discord. What a genius!

There are parallels as well as contrasts between these two great men. Both were so convinced of the value of experience that they sought to learn from common people. Thus Bacon, speaking of Peter of Maricourt:—

"One man I know, and one only, who can be praised for his achievements in this science. . . . He is ashamed that any things should be known to laymen, old women, soldiers, ploughmen, of which he is ignorant. Therefore he has looked closely into the doings of those who work in metals and minerals of all kinds." And again, "They are willing to lower themselves to the level

of husbandmen, of poor women, of children. Many things are known to the simple and unlearned which escape the notice of the wise."

In this spirit Galileo opens his dialogues:—

"The constant activity which you Venetians display in your famous arsenal suggests to the studious mind a large field for investigation, especially that part of the work which involves mechanics; for in this department all types of instruments and machines are constantly being constructed by many artisans, among whom there must be some who, partly by inherited experience and partly by their own observations, have become highly expert and clever in explanation."

Three hundred years again, and Faraday, perhaps Galileo's only superior as an experimenter, writes down:—

"Whilst passing through manufactories . . . we are constantly hearing observations by those who find employment in those places, and are accustomed to a minute observation of what passes before them, which are new or frequently discordant with received opinions. These are generally the result of facts, and though some are founded in error, some on prejudice, yet many are true and of high importance to the practical man. Such as come in my way I shall set down here, without waiting for the principle on which they depend."

This is indeed the scientific spirit, a long, long way from the schoolmen!

Both Bacon and Galileo were good Catholics, and both had sympathisers among the magnates of the Church, including the Popes. Yet both were imprisoned and had their teaching condemned, and both may be said to have forced their own imprisonment. Relying on their protectors in high places they attacked the orthodox teaching of their times, and with characteristic weapons, Bacon with the bludgeon of savage invective, Galileo with the rapier of irony and sarcasm. Yet though suppressed for the moment, their work was not in vain. It was a passage from the "Opus Majus," quoted verbally in Pierre d'Ailly's "Imago Mundi," which Columbus cited as one of his inspirations to the discovery of the New World, and his proposals for the reform of the Calendar bore fruit in the sixteenth century. So, too, when Milton found Galileo practically a prisoner at Arcetri, old, bereaved, grievously ill and blind, it might have seemed that the powers of obscurantism had prevailed. But the very year when he lay broken and dying there was born in Lincolnshire a child, Isaac Newton, who was destined to bring his work to a triumphant conclusion and place him on a pinnacle of glory. You cannot crush the human spirit. In these days we may take courage from these two great men, for even though freedom should be trodden under the iron heel of military despotism, which God forfend, it will revive again, and this time it will not wait three hundred years for its resurrection.

TOOTH OF MAN AND BEAST.

A Manual of Dental Anatomy, Human and Comparative. By Dr. C. S. Tomes. Seventh Edition. Edited by Dr. H. W. Marett Tims and Prof. A. Hopewell-Smith. Pp. vi+616. (London: J. and A. Churchill. 1914.) Price 15*s.* net.

IF one imagines, for tableau representation, a quickening of the action in the slow-moving epic of organic evolution, a forward position of immense significance was surely in sight when the scaly armour of certain fishes became so elaborated that they went forth muffled in spines to the very lips. And the defence and protection was completed—and something more than these was initiated—when the dermal spines were drawn over the lips and carried into the mouth itself, there to form the beginnings of those wonderfully diversified structures which are known as teeth. Many eminent workers have, along various byways of inquiry, been attracted to, and held by, the study of odontology, and have helped to build up a most noticeable body of scientific knowledge. Tomes's "Dental Anatomy" still holds the field as, perhaps, the most successful effort to gather and arrange the facts, and present them in a "manual" suitable for students and beginners. The author and his editors are to be congratulated upon the production of the seventh edition, in which the make-up is improved by a larger page and type, and by bringing the matter descriptive of illustrations directly under each figure, instead of at the foot of the page.

The desire of the editors "to incorporate in the volume the results of recent research" has not brought about the addition of much new matter. But the ordinary student is not likely to be found grumbling before such a well-spread table; the number of published "note-books" and compilations of the "cram" order that have sprung from the parent work of Tomes shows that he suffers gladly any reduction of bulky fare. The acute controversies that turn upon such problems as enamel formation, dentine innervation, and the homologies of teeth, remain apparently unsettled, and in regard to these and many other disputed points there may be some disappointment that, after the lapse of a decade, the very wide catholicity of Mr. Tomes's interesting discussions

has not now been amended in the direction of more definite leading and instruction. Now and then the accepted facts are so entangled in lengthy argument—of historical interest merely—that the student must have difficulty in picking them out.

The chapter on the development of the jaws is brought up to date by the inclusion of a section prepared by Prof. Fawcett, giving the results of his own recent investigations. The editors may not yet have noticed that the end of this excellent *résumé* is wrongly indicated by misplaced quotation marks. In another part of the same chapter, on p. 237, the omission of "so that" from the beginning of the sixteenth line is probably unintentional. The statement that the first permanent molar of man makes its appearance "about the eleventh year" is an example of the undetected clerical slip that occasionally bears a charmed life through successive editions.

In regard to the difficulty of deciding what teeth may be missing in dentitions that are reduced in number from the so-called "typical" mammalian formula, Dr. Marett Tims has added a useful reminder: "It is doubtful whether the homologies of the teeth, when one or more of the series is absent, can be correctly interpreted from an examination of the skulls of adult animals, whether recent or fossil." In order to determine the position of any tooth vestiges present, a microscopical investigation of the developing tooth should (he says) be made whenever possible. The same writer contributes a series of diagrams which indicate clearly the number of dentitions represented in the various groups of the mammalia.

Mr. Tomes's criticism of the well-known Cope-Osborn theory of the evolution of mammalian teeth has, in the present edition, been qualified by one or two editorial notes presaging a more diminishing belief in the doctrine of trituberculism. Cope's *kinetogenesis* idea of the evolution of tooth forms, either by a sort of plastic yielding, or a stimulus to the formation of new cusps at the points of the greatest wear, can scarcely be thought to have survived the disintegrating objections clearly and restrainedly put forward by Tomes. In the second part of this edition, the arrangement of the orders has been altered and brought somewhat nearer to a logical sequence. The teeth of primates are dealt with in the last chapter, and here are placed tentatively—yet with a painstaking attention to the honourable rights of precedency—the five or so known types (including the recently-discovered *Eoanthropus dawsoni*) that lie upon or near to the line of descent of later man. Adjudgment of the conflicting claims of these "poor relations" to be the direct ancestors of modern man is a most difficult matter. The subject is naturally a widely attractive one, so that when discussions of it are forward even those not ordinarily concerned with dental science will prick an ear and often draw near to take a hand. But when, as often happens, the clues to the interpretation of fragmentary remains of man or animal have to be sought mainly in the imperishable teeth, the very fullest available knowledge of all the tooth tissues must be applied to the problem.

In the sifting and evaluation of evidence, many of Tomes's discussions are models of scientific criticism. His handling of debatable subjects is marked also by a literary style of charm and flexibility, in which he moves smoothly and easily forward towards a concentration on the essential or significant points. It can safely be said that responsibility for the editorship of this new edition has fallen into competent hands. While that is so, many will hope that Mr. Tomes may continue to hold at least a watching brief for odontology.

ECONOMIC ENTOMOLOGY FROM WEST AND EAST.

(1) *Manual of Fruit Insects.* By the late M. V. Slingerland and C. R. Crosby. Pp. xvi+503. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1914.) Price 8*s.* 6*d.* net.

(2) *Indian Forest Insects of Economic Importance: Coleoptera.* By E. P. Stebbing. Pp. xvi+648+lxii plates. (London: Printed by Eyre and Spottiswoode, Ltd.; sold by Constable and Co., Ltd., and others, 1914.) Price 15*s.*

(3) *Crop Pest Handbook for Behar and Orissa (including also Western Bengal).* Department of Agriculture, Behar and Orissa. Pp. xxiii+Leaflets 84+Appendices 21+plates liv. (Calcutta: Thacker, Spink and Co., 1913.) Price 4 rupees.

(1) STUDENTS of applied entomology all the world over remember gratefully the late Prof. M. V. Slingerland, whose writings in the Bulletins of the Cornell University of Ithaca and elsewhere, form a storehouse of information on insect life-histories and on practical means for destroying pests. And now Mr. C. R. Crosby has completed the pious task of editing a quantity of manuscript left unfinished by Slingerland when, five years ago, he was taken from us. The result of this collaboration is a handy volume in which two hundred species of orchard insects common in the United States are described and figured. In the space allotted the descriptions are

necessarily brief, but many facts are conveyed in short paragraphs—thanks to a plain and effective style—while references are given to special memoirs. As might have been expected, the literature quoted is entirely American, though not a few of the insects described are common European pests on which some useful observations have been made on this side of the Atlantic. European workers, however, will be glad to have the American experience with regard to these species, and to others which are near allies of common "old-world" kinds. The few pages of "general considerations" on the structure of insects are the weak part of the book; it is disappointing to see the cuticle called a "shell" on p. 2 and a "skin" on p. 5. The concluding chapter deals with the practical use of insecticides. Illustrations comprise nearly four hundred figures, some of which are reproductions of excellent drawings, while the rest are photographs of somewhat unequal value. Indeed, examples of extremes of merit and demerit in natural history photography might be drawn from this volume.

(2) Mr. E. P. Stebbing, who not long ago left the Indian Forest Service to become head of the Forestry Department of Edinburgh University, has provided in this handsome volume a worthy monument of his work in the East. His "Manual of Elementary Forest Zoology for India," published in 1908, was noteworthy for many original observations on the life-history of Indian forest beetles. The present work—a large royal octavo of more than 600 pages, with 63 plates and 400 text-figures—is entirely devoted to those Coleoptera which are known to be of economic importance in Indian forests. The arrangement is systematic, the large series of beetles described being set forth by their families; it is to be regretted that the grouping of the families is that given by Dr. D. Sharp in the "Cambridge Natural History," a grouping the convenience of which does not atone for its artificiality. In the details of his systematic work Mr. Stebbing has wisely sought help from a number of specialists, for no one man can nowadays deal effectively with all the members of a great insect order from an extensive tropical region. Messrs. C. J. Gahan and G. Arrow of the British Museum, Mr. G. Lewis, Col. F. W. Sampson, Mr. G. A. K. Marshall of our Imperial Bureau, M. P. Lesne of the Paris Museum, and M. G. Severin of the Brussels Museum are among those who have identified, and where necessary described, specimens of their favourite families. The classificatory work may therefore be relied on, and with Mr. Stebbing's accounts of life-histories, habits, effects of the insects on trees, and relation of the insect fauna to the forests in a wide sense, a mass of valuable information is here gathered for the Indian student of the present and the future. As to the illustrations, most of the photographic reproductions are beautiful, and, with the exception of a few rough sketches, the drawings may be highly praised.

(3) A volume consisting of a number of leaflets, briefly describing common crop pests of Behar, Orissa, and Western Bengal is introduced by a preface by Mr. E. J. Woodhouse; he tells us that the work has been compiled by Mr. S. K. Busu, who is responsible for the few fungi that are included, and Mr. H. L. Dutt, who deals with the insects. Among the latter the presence of *Pieris brassicae*, *Aphis brassicae*, and other well-known British crop-pests is interesting. The leaflets are of quarto size, each being illustrated by an admirably printed coloured plate. These plates, which, we are told, "have not been previously published, but are intended for use in memoirs in course of preparation by the Imperial Entomologist," will doubtless make it easy for the Indian farmer to identify his insect enemies. They will also prove of no little service to the working entomologist. G. H. C.

TEXT-BOOKS OF CHEMISTRY.

(1) *Chimie Physique Elementaire.* By E. Aries. Tome Premier. Les Principes Generaux de la Statique Chimique. Pp. xxx+212. (Paris: A. Hermann et Fils, 1914.) Price 4 francs.

(2) *A Manual of Practical Physical Chemistry.* By Dr. F. W. Gray. Pp. xvi+211. (London: Macmillan and Co., Ltd., 1914.) Price 4*s.* 6*d.*

(3) *Notes on Elementary Inorganic Chemistry.* By F. H. Jeffery. Pp. iv+55. (Cambridge University Press.) Price 2*s.* 6*d.* net.

(4) *The Elements of Chemistry.* By H. L. Bassett, with an introduction by Prof. W. J. Pope. Pp. xii+368. (London: Crosby Lockwood and Son.) Price 4*s.* 6*d.*

(5) *Chemical Calculations.* Pp. vi+136. *Chemical Calculations (Advanced Course).* Pp. vi+48. By H. W. Bausor. (London: University Tutorial Press, Ltd., 1914.) Price 2*s.* and 1*s.* respectively.

(6) *The Fixation of Atmospheric Nitrogen.* By Dr. J. Knox. Pp. vii+112. (London: Gurney and Jackson, 1914.) Price 2*s.* net.

(1) THE French text-book of physical chemistry would scarcely be regarded in this country as justifying the author's description of it as "elementary." It is essentially an exposition of the work of Willard

Gibbs, with additional theorems and applications developed by the author. Although the book deals with such familiar subjects as chemical equilibrium, the laws of mass action, the phase rule, and osmosis, it does not descend to the discussion of experimental facts, and contains no illustrations of apparatus, no tables of data, and none of the usual graphical representations of equilibria. On the other hand, the mathematical treatment of the problems is very thorough and exact. The book will not be likely to attract the average chemist, who prefers to make use of theories only when they can be kept closely in touch with experiment; but a student who had taken an "honours" degree in mathematics would probably enjoy a course of chemistry in which theory reigns supreme and the limitations of experiment are thrust into the background, or perhaps postponed to a later volume of the series.

(2) Dr. Gray's "Practical Physical Chemistry" contains a series of thirty-nine exercises, which may be carried out by individual students in periods of two to three hours. It is undoubtedly one of the best books of the kind that has yet been published. The exercises deal with real problems and with real apparatus, in a way that should bring the student into touch with modern methods of exact measurement, and make it easy for him to proceed to original work in physical chemistry if the opportunity should arise. The preliminary discussion on "Accuracy" is particularly welcome, and should provide a useful check on the slovenly and inexact measurements which are the chief menace to the success of a course of experimental work in physical chemistry.

(3) Mr. Jeffery's "Notes" are a series of summaries of the data that are necessary for answering ten of the questions that are most commonly set in examinations on chemistry, *e.g.* on acids, salts and bases, oxides, oxidation and reduction, electrolysis, etc. To the student preparing for examinations the advantage of having these data in a compact form will be obvious, though he might well expect to find most of the information in a general text-book. The compilation has been done carefully, and criticism may be confined to points of detail. Thus, it is curious to find no reference at all to the sour taste by which acids first acquired their reputation, although their action on litmus and their electrolytic properties are described; the reader is also not told whether the solubility of metallic hydroxides in caustic alkalies brings them within the category of acids or not. It is, however, satisfactory to find that the author has realised the difficulty of *defining* acids, salts, and bases, and is for the most part content with *describing* their characteristic properties; such a description might well be made into a historical statement showing the gradual development of the idea of an "acid" in the hands of Lavoisier, Berthollet, Gay Lussac, and Laurent, and of a "salt" in the hands of Boyle, Lavoisier, Berzelius, Laurent, and others. In dealing with students, it is a pity to allow them to "obtain" common salt by mixing caustic soda and hydrochloric acid, and to regard this as a "preparation" of the salt; an exercise on the recrystallisation of rock salt or the extraction of common salt (and Epsom salts) from sea-water would be of greater value, and much more in touch with reality.

(4) Mr. Bassett's book is intended for medical and dental students who require to obtain within the course of a single year some knowledge both of inorganic and of organic chemistry. The requirements of such a syllabus are in no way incompatible with a sound scheme of instruction; the study of alcohol, for example, affords excellent material for explaining methods of purification, tests of purity, and the fundamental principles of analysis in a course of general chemistry. Roscoe's "Lessons" may be quoted as a very successful example of a combined course of inorganic and organic chemistry; but the medical student of the present day has been somewhat badly served in the matter of text-books, and Mr. Bassett's book is an attempt to fill a gap that is recognised clearly by those who are responsible for the teaching of medical and dental students.

In spite of certain merits that the book possesses, it is doubtful whether it will secure any extensive foothold in the medical schools. Actual experience shows that it is a mistake to discuss the periodic classification of the elements before any of them have been studied in detail. Moreover, this classification is not a suitable basis for an introductory study of the elements. The author has boldly adopted it, and described the elements in the order in which they occur in Mendeléeff's table. He therefore postpones the consideration of oxygen and chlorine until all the metals, except those of the iron-group, have been described. Here again, as experience shows, he has made a fatal mistake, and not one student in a hundred is likely to benefit by using the scheme which the author has adopted.

Whilst most of his statements are accurate, the author has admitted several errors, from which the student might reasonably expect to be protected. He would be unwise, for example, to assert with the author that barium monoxide is prepared by heating the carbonate, or that in a combustion oxygen is *drawn* through the ap-

paratus. The definitions of acids, bases, and salts are novel, but altogether bad. If they could be taken literally, they would include amongst the bases such diverse substances as oxygen, phosphorus, potassium permanganate, sugar, alcohol, camphor, benzene, toluene, formic acid, oxalic acid, since all these substances can "react with an acid, giving water as one of the products." Amongst the "salts" one would find chlorine, phosphoric acid, oxalic acid, ethyl acetate, ethylene, ether, camphoric acid, nitrobenzene, benzoic acid, carbon monoxide, and carbon dioxide, since each of these may appear in the guise of "substance, other than water, produced by the reaction of an acid and a base," as defined in the opening sentences of the chapter.

(5) Mr. Bausor's two books on chemical calculations may be commended on the ground that the problems bear a very close resemblance to those that would be met with in the actual experience of a chemical worker. No further commendation is needed except to say that the range of subjects and the working out of typical problems are alike satisfactory. The only improvement that may be suggested is to the effect that greater interest would be aroused and more useful information imparted incidentally if the author had drawn more freely on numerical data taken from classical experiments, such as those of Berzelius and of Stas, together with more modern experiments by Morley, Richards, Morse, Guye, and others.

(6) Dr. Knox's monograph on the fixation of nitrogen includes a great deal that has become very familiar in recent years, but the subject has been treated in a very satisfactory way. In addition to the well-known details of the Birkeland-Eyde process, ample space is devoted to the theory of the operations and to the many scientific experiments that have been made to elucidate them. The section on the ammonia equilibrium is particularly welcome, in view of the fact that this method of fixing nitrogen has been exploited in the technical Press to a much smaller extent than the processes described in the other two sections of the book. It is not usual to permit any detailed study of technical processes in an elementary course of chemistry, yet nothing but good would result if this little monograph were added to the curriculum of such a course; the problems with which it deals are so important and the underlying theories are so illuminating that they might well be used to add an element of romance and a new interest to the oft-told story of elementary inorganic chemistry.

T. M. L.

OUR BOOKSHELF.

Pattern-making. By F. W. Turner and D. G. Town. Pp. v+114. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1914.) Price 4*s.* 6*d.* net.

THIS little book is intended for young pattern-makers, and presents a general survey of the most suitable materials, the special tools, and the fundamental processes of the trade, together with the relations of the pattern-shop with the allied departments, viz., the drawing office, the foundry, and the machine shop. The pattern-maker is principally concerned with the foundry, and throughout the book we find clear and concise descriptions of moulding processes, well-illustrated, together with discussions of the sometimes conflicting requirements of the moulder and pattern-maker, and explanations of the compromises which have to be adopted. In recent years the development of machine tools, both in the foundry and in the pattern-shop, has altered considerably the art of pattern-making and also the stock of hand-tools composing the private equipment of the artisan.

The book contains many interesting devices which have been developed by American workmen for special purposes, and in this respect will be found to be of considerable interest even to older pattern-makers in this country. A special word may be said regarding the illustrations in the book; these are excellent, both as regards the selection of typical examples and also clearness of drawing and reproduction.

We can confidently recommend the book to young pattern-makers and others connected with engineering, not that it will make them good pattern-makers—experience alone will produce this result—but on account of the broadening of views which is sure to be acquired during the perusal of its pages.

Foundations: a Short Text-book on Ordinary Foundations, including a brief description of the methods used for Difficult Foundations. By Prof. M. A. Howe. Pp. vii+110. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1914.) Price 5*s.* 6*d.* net.

IN this book the author has treated in an elementary manner both the fundamental principles involved in the design of foundations and also standard methods of carrying out the actual work. Special treatment is given of the footing courses of structures, these being considered apart from the foundation proper. The Rankine theory is adopted for the permissible bearing pressure on soils, and a modified form of Rankine's formula is given; there is a brief discussion of the precautions which must be considered in dealing with various descriptions of soil. Several different methods of construction in the footing courses are given, such as concrete, brick, reinforced concrete, grillage, I beams, and cantilevers; these are clearly described, and the student will have no difficulty in following the methods of calculation. A feature of the book consists in worked-out examples of each case; these will be found to be of

great service to the reader. The treatment of the design and driving of piles is good and up-to-date, as is also that of bridge piers and abutments.

The book possesses the merit of presenting a fairly complete exposition of a rather difficult subject without unnecessary profusion of detail, and will be welcomed by many students who desire more information regarding foundations than is to be found in the text-books dealing with the theory and design of structures generally.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

The Camera in Australia.

Now that most members of the overseas party of the British Association have, happily, returned safely from the meeting in Australia, it seems opportune to remind members of the scheme for the exchange of photographic prints announced in the *Journal* (issued in Melbourne on August 12, 1914, p. 2), for which Dr. A. Holt and myself became responsible. The aim of the scheme was to economise our stock of plates and to prevent unnecessary duplicating of prints. Thus in the advance party in West Australia one member took a photograph of one striking object, a second member of another, on the understanding that all members of the party would be able to obtain, at their own expense, copies of the prints of the photographs, either by an exchange of photographic prints taken by themselves or by payment of the cost of the print supplied. It was an essential feature of the scheme that the photographers themselves should not suffer financial loss in meeting the requests of members for prints.

The scheme is sufficiently comprehensive to include not only illustrations of plants, animals, and scenery, but also of any features appealing to members specially interested in any one of the many Sections of the Association's activities. Thus timber felling, aboriginal camps and their life, manufacturing processes, as well as the lighter side of our visit, such as life on board ship and garden-parties, come within the scheme of exchange. In fact, if any member has photographs of interest taken either in Australia or on one of the many routes members followed to and from Australia it is hoped he will be willing to offer prints of the same to others. Though the scheme was intended in the first instance to apply to members of the overseas party and to local members of the Australian meeting, there is nothing to prevent it from developing so that members of the Association who were unable to attend the meeting may have the opportunity of obtaining a set of the photographic prints offered for exchange.

Will members willing to participate communicate with me as soon as possible? In each case a list of the prints available, together with the address of the supplier and the cost of the prints, should be given. It would be helpful if a set of the prints could also be sent for inspection and subsequent return.

From these lists a general list will be prepared and sent to each participator in the scheme. It will probably be an advantage to all concerned if the exchange is worked from one centre. This we shall be willing to undertake in the hope that all will co-operate by promptness of reply in making the task as light as possible.

It is hoped that the series of prints will serve not only as a permanent record of our unique and delightful experience, but also as illustrative material for teaching, lecture, and museum purposes. Thus members could at this moment help many deserving charities by giving lectures on Australia with these prints for illustration.

T. JOHNSON.

Royal College of Science, Dublin.

Magnetic Disturbances, 1913.

DR. W. N. SHAW has asked me to send you an account of an examination, undertaken by his instructions, of the Eskdalemuir magnetograms for 1913. The examination indicates that the disturbances from the level of the quiet day inequality fall into two distinct classes A and B.

A.—The disturbance was due to a magnetic force which remained in a more or less fixed direction while changing sign in an oscillatory manner. Throughout the year the direction of this force had an azimuth lying within a range of about 60° on either side of the magnetic meridian and an inclination to the horizontal lying within the narrow limits 0° and 6°. The slope was upwards towards the more northerly end. An especially clear example occurred on March 23d., 14h. to 18h.

Pulsations of periods 2 to 15 minutes fall into this class. A search also brought to light longer periods of 19, 23, and 26 to 30 minutes. Beyond this there are measured periods of 180, 155, 148, 109, 100, 95, 85, 80, 80, 78, 74, 66, 60, 38 minutes, but the measurements have been uncertain to, say 15 per cent., and should perhaps be taken only to indicate the existence of actual periods near 79 minutes and between 150 and 180 minutes. The crowding together of the shorter periods of 2 to 15 minutes is suggestive of a harmonic series. The longest periods noted were recorded on the afternoons or evenings of June 17d., 21d., 23d., July 9d., 10d., 12d., 15d., 18d., 25d., August 7d., 9d., 11d., 28d. Class A appears to resemble the type of disturbance that Birkeland has attributed to a ring-shaped electric current encircling the earth at a great height above the ground in the plane of the magnetic equator. The periods noted above are enormously greater than the time (0·13 second) taken by an electromagnetic wave to travel round the earth. Similarly the wave-length of sodium light is enormously greater than the circumference of the sodium atom. Can there be a similarity of explanation in the two cases?

B.—The direction of the disturbing magnetic force was not fixed as in class A, but wandered about, usually remaining within 60° of a plane normal to the undisturbed force. The large, slow "bays" near midnight usually fell into this class. For example, the bays on October 7d., 0h. to 4h. Sometimes the disturbing force rotated as if it were rigidly attached to an axis nearly coinciding with the direction of the undisturbed force; the rotation was clockwise to an observer looking north and down. Class B appears to resemble the types of disturbance which Birkeland has called "polar" and "cyclo-median."

Class A disturbances sometimes occurred without class B, but class B seldom occurred without A.

Disturbances of the A class were identified by viewing the traces of the components laid over one another and pressed against a window-pane. The correspondence of the oscillations in the three components determined the matter.

Further particulars will be published in the British Meteorological and Magnetic Year Book, part iv. 2, 1913.

It will be interesting to know whether other observers have found corresponding phenomena in working up records for 1913.

L. F. RICHARDSON.

The Observatory, Eskdalemuir, Langholm, Dumfries-shire, December 11.

THE QUATERNARY ICE AGE.[1]

THIS handsome volume is a notable contribution to the voluminous literature relating to glacial geology. Its scope is comprehensive, for it describes in a crisp and lucid form the succession of Glacial and post-Glacial deposits in Europe and North America, the living and extinct Quaternary mammals, the successive stages of culture of Palæolithic and Neolithic man, the various theories of the cause of the Ice age, and the isostatic theory of the Quaternary oscillations of sea-level. Much controversial ground is traversed in this wide field. Throughout the volume the author maintains a critical attitude and expresses his opinions freely. His chief aim has been to set forth what he regards as the solid basis of fact which throws light on the history of this fascinating epoch. Hence he discards classifications which, in his opinion, are not supported by conclusive evidence.

At the outset the potency of glacial action in modifying the surface features of a country is recognised. In proof of this contention reference is made to the over-deepening of valleys, the formation of mountain corries, the recession of corrie cliffs by sapping, and the excavation of rock basins due to differential erosion in harder and softer rocks. In the preliminary account of the Glacial drifts the opinion is expressed that many erroneous conclusions regarding the retreat and re-advance of the ice and the occurrence of inter-Glacial periods have been based on intercalations of sand, gravel, and clay between sheets of Boulder Clay. The so-called "Upper Boulder Clay," in many instances, may be merely englacial moraine, which settled down on sub-glacially-formed sediments on the disappearance of the ice. On the other hand, it is admitted that, where these intercalated deposits preserve their horizontality over wide areas, they probably point to retreat and re-advance of the ice. Their inter-Glacial value must be determined by local circumstances.

The author's attitude towards the inter-Glacial question is clearly defined. He is of opinion that the elaborate systems of the older inter-Glacialists may all be set aside as unproved, and that we ought to accept the mono-Glacial hypothesis until we can prove one inter-Glacial period. Nevertheless instances are adduced which prove oscillations of climate of more or less magnitude. The recent researches of Victor Madsen, Nordmann, and Harz on the Cyprina Clays of Denmark, North Germany, and Holland, furnish satisfactory evidence. These fossiliferous deposits occur as transported masses in the Boulder Clay in the east of Denmark and north of Germany, while to the west and south of these areas they are to be found in their original position, resting on Boulder Clay and fluvio-Glacial gravels. Therefore they cannot be pre-Glacial. They must have been laid down during a period of recession of the ice. In view of the width of the belt containing transported masses of these Eemian deposits in the Boulder Clay of the Baltic ice sheet, the extent of the recession cannot be less than fifty miles. But the presence of well-marked southern species in the marine fauna may indicate a greater recession, and probably the complete disappearance of the ice. These investigations confirm the opinion of Prof. James Geikie and others who assigned these deposits to an inter-Glacial period.

The series of Glacial and inter-Glacial periods worked out by Penck and Brückner in the Alps is adopted. Special allusion is made to certain inter-Glacial deposits proving oscillations of climate, such as the "Höttinger Breccia," the "Schieferkohlen" of Dürnten, the plant-bearing beds of Re and Pianico, all of which are doubtfully referred to the Riss-Würm inter-Glacial period. It is further shown how the evidence from plant remains is confirmed by the Quaternary fauna occurring in Alpine lands; the twofold repetition of the arctic fauna comprising the mammoth, woolly rhinoceros, and reindeer, being separated by the inter-Glacial fauna with *Elephas antiquus*, Merck's rhinoceros, and the red deer.

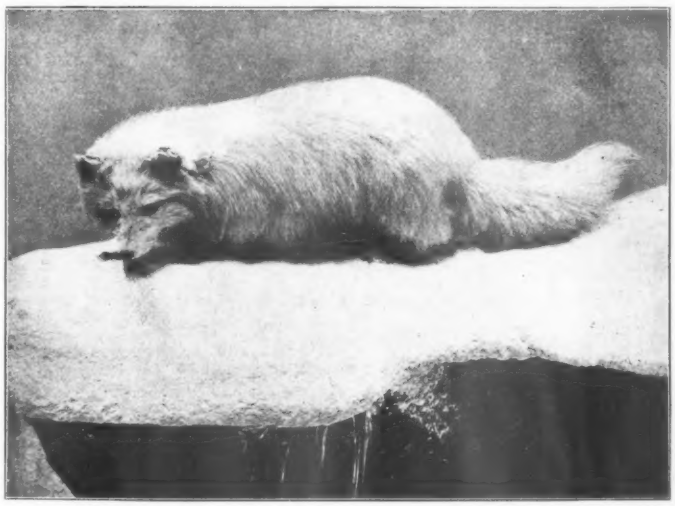

FIG. 1.—The Arctic Fox (*Vulpes lagopus*) in winter coat. From a specimen in the British Museum. From "The Quaternary Ice Age."

In the description of the American drifts the classification presented is not so comprehensive as that of Prof. Chamberlin. It begins with the Kansan Till sheet and ends with the later Wisconsin Boulder Clay. The cautious attitude of the author in dealing with the classic Don valley

[1] "The Quaternary Ice Age." By W. B. Wright. Pp. xxiv+464. (London: Macmillan and Co., Ltd., 1914.) Price 15s. net.

section near Toronto scarcely does justice to the evidence indicating great climatic changes so well described by Prof. Coleman.

In England, only one out of many so-called inter-Glacial deposits is considered to have stood the test of critical examination, viz., the shell-bearing clay of Kirmington, which is overlain and underlain by Boulder Clay. It indicates a recession of the ice-margin between the periods of deposition of the purple and Hessle Clays, when the sea stood at a higher level in the estuary of the Humber than it does at present. The sequence of the drifts, the oscillations of the ice, the westward shifting of the centres of glaciation, and the theory was first advanced by Dr. Jamieson to account for marine sediments of late Glacial age in Scotland. He believed that the earth's crust sank under the weight of ice and rose again when the ice disappeared. The author argues with much ingenuity that the late-Glacial and post-Glacial changes of level in Scandinavia may be accounted for by isostatic recovery from the effects of ice-load combined with a single oscillation of the sea-level.

This volume will be useful to students as a synopsis from a particular viewpoint of modern research in Quaternary geology. The illustrations deserve special mention. In selection and

Photo.] [*R. Lunn.*

FIG. 2.—Section of glacial sand and gravel resting on Boulder Clay on the river Spey, opposite Rothes, Banffshire, Scotland. From "The Quaternary Ice Age."

Glacial drainage as worked out by Mr. Lamplugh, Prof. Kendall and others is clearly set forth.

The classification of the culture stages of Palæolithic man is based on that of G. de Mortillet, and of Neolithic man on that of Montelius. Special emphasis is laid on the great break between the Palæolithic and Neolithic industries of Europe. The transition phases (Campignien, Tardenoisien, and Asylien), which are supposed by archæologists to bridge this gap, fail to demonstrate a passage between the two.

One of the most interesting chapters in the volume is that dealing with the isostatic theory of the Quaternary oscillations of sea-level. This execution they are excellent. Two of them (Figs. 1 and 2) are here reproduced. JOHN HORNE.

WIRELESS TELEPHONY.

THE system of wireless telephony upon which Capt. Colin and Lieut. Jeance, of the French Navy, have been at work for some years has recently been considerably improved, and some very successful experiments were carried out last June, when, during some tests in which long-distance communication was established in France by means of an aerial only 164 ft. high, speech was incidentally overheard on a small amateur installation in Lincolnshire. The continuous

waves used for transmission are produced by three arcs connected in series. Each has a negative electrode or carbon only 1·5 mm. diameter, and a copper disc negative electrode above it, which forms part of the bottom of a cylindrical tank filled with paraffin and cooled by water circulation. The carbon electrodes are beneath this disc, and their height is regulated by means of a crank outside the arc chamber. The arcs, which are very short, burn in an atmosphere produced by mixing acetylene and hydrogen generated from calcium

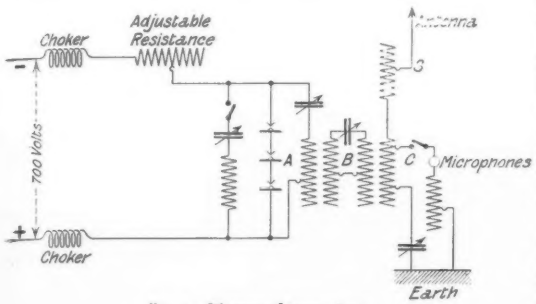

FIG. 1.—Diagram of connections.

carbide and calcium hydride respectively, and this not only prevents the burning away of the carbons, but actually increases their length slightly during operation.

A 750-volt dynamo supplies the three arcs in series, and there is means to regulate its pressure between 500 and 750 volts. Two choking coils (to prevent high-frequency currents from flowing back to the dynamo) and an adjustable resistance reduce the voltage at the terminals of the three arcs to between 250 and 350 volts. A current of from $3\frac{1}{2}$ to $4\frac{1}{2}$ amperes is employed.

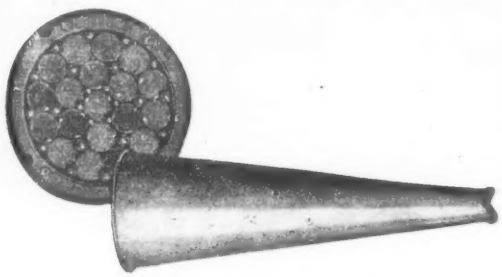

FIG. 2.—The microphone and megaphone.

The diagram (Fig. 1) shows the connections of the microphone and the oscillatory circuit. The principal oscillatory circuit consists of an inductance and variable condenser, connected in parallel with the arcs A. An intermediate oscillatory circuit B, consisting of an inductance and variable condenser, is utilised to couple the principal circuit with the aerial, and ensures that multiple waves generated in the main circuit are not transmitted to the aerial, the result being that only a single wave is emitted. The aerial circuit consists of an inductance coupled with the circuit B and a variable condenser. A variable self-induction is also used in the aerial.

In the microphone circuit are nineteen carbon microphones connected in series, and so arranged that they are all acted upon by the voice simultaneously by means of a megaphone. The microphone and megaphone (drawn to different scales) are seen in Fig. 2; the large end of the megaphone covers the microphone. The microphone cells are connected between the variable inductance of the oscillation transformer and earth, as shown at C. This has the double advantage of avoiding sparking, such as always occurs in the microphones when they are placed directly in the aerial circuit, and does not limit the energy which can be taken by them. The station has two complete microphone equipments, with a change-over switch, so that each can be used for a short time and the other microphone allowed to cool, as naturally very large currents are employed.

The transmitting coils consist of flat spirals of copper strip, and the condensers are of the glass-plate type. Arrangements are provided for very exact tuning by means of variable air condensers. The wave-length of transmission can be varied between wide limits; in the official tests a wave-length of 985 metres was used.

HIGH EXPLOSIVES IN WARFARE.

AT the present time explosives are playing such a prominent part in the war that the interest and attention of the most peace-loving citizen are necessarily aroused by the terrible results undoubtedly produced, or are more morbidly affected by the tales of the alleged marvellous effects which are yet to be experienced. A few notes on the most important explosives being used in war may therefore be of special interest just now.

The explosives which can be advantageously employed in warfare are by no means the most powerful which the chemist can produce, or which may even be used in civil engineering or mining operations. The military high explosive must be sufficiently insensitive to shock to prevent its being exploded when struck by projectiles, or when submitted to the shock of being fired from a gun as the charge of shell, else it might prove as dangerous to the user as to the enemy. Thus the nitroglycerine class and many other explosives are excluded.

For many years gun-cotton, containing a considerable amount of moisture, was largely used for naval and military purposes. In the moist state it is extremely safe, but can be easily detonated when a small primer of dry gun-cotton is fired in contact with it. The explosive effect is great, and it provided an excellent and safe explosive for military mines and purposes of destruction, and as a charge for torpedoes. It was not, however, suited for use in shells.

The high explosives chiefly being used in the present war for shell-filling are picric acid, trinitro-

toluol, and ammonal. Picric acid, with or without the admixture of various ingredients, has been in use at one time or another in most countries under the names of melinite, lyddite, shimose powder, etc. Until picric acid came into use, black gunpowder formed practically the only explosive used as a bursting charge for shells, and the use of picric acid was a great advance from the destructive point of view, as its explosive power was very much greater. Picric acid, although sufficiently insensitive to shock, has the property of readily attacking metals and forming picrates, which are much more sensitive and liable to explosion. This involves special precautions in dealing with it, and is an undoubted disadvantage.

Ammonal is a mixture consisting of ammonium nitrate, trinitrotoluol, charcoal, and aluminium in fine powder. It is very safe, and is more powerful than picric acid, but owing to the hygroscopic character of ammonium nitrate, its chief constituent, it has specially to be protected from moisture, which reduces and, if in sufficient quantity, destroys its power of explosion. It is largely used by the Austrians.

Trinitrotoluol is undoubtedly now the most widely used high explosive for military purposes under the names of "Trotyl," "Tritolo," "Tolite," "Tritol," "Trilite," and "T.N.T.," according to the nation using it.

"T.N.T.," as it is called in the British Service, has attained its position by virture of its merits. It is used in a state of great purity; it is chemically stable and without action on metals. It is unaffected by water, and can be fused and run into shells in the molten state. It is less sensitive to shock than picric acid. Hard blocks of suitable size and shape are covered by electro-plating them with a coating of copper, which prevents the blocks from being broken and having their edges chipped. In this form "T.N.T." is used for demolishing bridges, etc. Although not quite so powerful as picric acid, its other advantages make it at present perhaps the best available explosive for military use.

The destructive effect of an explosion is caused by the almost instantaneous conversion of the solid explosive into gases, at a very high temperature, with consequent sudden exertion of an enormous pressure. From the purely disruptive point of view, the composition of the gas produced is not necessarily of importance, the determining factors being the volume of gas, the heat produced, and the velocity of detonation. When however an explosion takes place in a confined space, then in addition to the disruptive or shattering damage, the components of the gas produced may have an injurious effect on anyone having to breathe it.

In the case of explosives for use in civil life, as in mining work, care is taken by adjusting the composition of the explosive that the gases produced shall not have a deleterious effect on the miner. In military operations this consideration does not arise; indeed, it may be maintained the more deadly the effect of the fumes the better.

Picric acid and "T.N.T." are definite chemical bodies, but owing to insufficiency of oxygen are not completely converted into gas on explosion, a considerable amount of carbon being set free. This accounts for the black smoke which is seen when these bodies are exploded.

In the earlier determinations, when explosives which contained insufficient oxygen for complete oxidation of the carbon and hydrogen were fired in a closed bomb, and the resulting gas analysed, it was found that its composition was affected by the density of loading. The higher the density of loading the higher the pressure, accompanied by increase of carbonic acid and decrease of carbonic oxide. Methane, which was absent or only in very small quantities at low densities of loading, increased steadily as the pressure increased. It was, however, recognised that the composition of the gas so found did not necessarily represent the composition at the moment of explosion, for the analysis was made some time after and when the gas had cooled. Consequently reactions had probably been taking place during the process of cooling. Finally, it was thought that the formation of methane was not a real result of explosion, but was due to secondary reactions during the cooling stage. The experimental difficulties of catching and fixing the gases at the moment of explosion were overcome by detonating the explosive in its own volume in a lead or porcelain bomb placed inside a larger evacuated steel bomb. The explosive had in this way to do work in bursting the smaller bomb, and the rapidity of cooling of the gas was thus so greatly increased that secondary reactions practically did not take place. When fired under these conditions, which correspond closely to those which exist when a shell explodes, the gases from ammonal, picric acid, and "T.N.T." were found to contain only small quantities of methane. In addition to carbonic acid, nitrogen, and hydrogen, ammonal contained about 24 per cent. and picric acid and "T.N.T." nearly 50 per cent. of the poisonous carbonic oxide. It is thus evident that where shells burst in confined spaces, in addition to the damage caused mechanically, those persons breathing the fumes may be fatally poisoned or seriously affected physiologically.

It has been suggested that the ingredients of shell charges may contain deadly poisons, but it seems improbable that any poison intentionally added to the contents of a shell would retain its toxic properties after the shock and heat of explosion. As seen above, the gases from the explosives now in use may be sufficiently poisonous under certain conditions.

The subject of explosives seems often to create a state of credulity, and to generate extravagance of statement on the part of the non-expert writer rarely effected by other matters. The unknown sometimes becomes truly appalling under his imaginative pen. Even inventors have been known to make wild statements in regard to their explosives! One should only accept with very many grains of salt the sensational statements which have appeared in some quarters as to the weird and deadly effects of recently-invented ex-

plosives. It is well, therefore, not to have exaggerated ideas of the power of explosives or to be unduly scared by the threat of explosives dropped from Zeppelins. The destructive effect of the large charges which can be fired from the huge howitzers used in the present war is terrible, but explosives have their limits.

While without doubt the damage done locally from the explosion of a large quantity of any explosive which might be dropped by a Zeppelin would be appalling enough, yet, judging from the effects of the accidental explosion of a couple of tons of nitroglycerine during manufacture, its area would be comparatively restricted, and the horrifying suggestions mooted of the coming total destruction of cities by explosives dropped from the sky may be ascribed to the imagination of the over-credulous. W. MACNAB.

PROF. INGRAM BYWATER.

ON December 18 there died in his house in Onslow Square the greatest Greek scholar of our time. Ingram Bywater was remarkable for the fact that he was imbued with the scientific spirit, and pursued the investigation of Greek thought—what may be called "the Greek thing"—in the true scientific method. He was in close sympathy with scientific men engaged in other branches of investigation, of the methods and results of which he had a remarkable understanding and appreciation.

Bywater was born in 1840, and after early days spent at University and King's College Schools, became a scholar of Queen's College, Oxford; then, in 1863, fellow and tutor of Exeter College. On the death of Jowett in 1893 he was appointed by Mr. Gladstone Regius Professor of Greek. It was chiefly through Bywater's influence that Exeter College was led to offer in 1872 a fellowship in the competition for which biology was to be the chief subject. Huxley and Rolleston acted as examiners on behalf of the College, and I had the good fortune to be the successful candidate. My college rooms were adjacent to Bywater's, and we became constant companions and friends. We often discussed—when the college slumbered—the life and learning of the world and our own special studies in a tobacco-parliament of two during the small hours of the night. I learnt more from him than I can say, and not only enjoyed his wise and humorous discourse and his freedom from pedantry, but formed a warm regard for his fine spirit, his wide learning, and his intellectual veracity. When my fellow-student Moseley—who had not competed for the Exeter fellowship owing to his appointment as naturalist on the *Challenger* expedition—returned from his travels, Bywater proposed that the college should elect him also to a fellowship, which was done.

In 1885 Bywater married the second daughter of Mr. C. J. Cornish, of Salcombe Regis, widow of Mr. Hans Sotheby, a former fellow of Exeter College. The work of her nephews, Charles and Vaughan Cornish, is well known to scientific naturalists. Bywater was singularly happy in his marriage, and after the death of his wife in 1908 never recovered his strength and vivacity. He resigned his professorship, but still gave his services to the University in connection with the Bodleian and the Press. He lived among his books in his London house, where after my own departure from Oxford in 1898 I was his neighbour and constantly with him as in the old days at Exeter College.

He had a most unfavourable opinion of the study of Greek as conducted under the examination and scholarship system at Oxford. "It is not Greek which they study," he said, "but an arbitrary and unreal creation of the examination system and the traditions of college tutors." He complained that when he was professor even those more serious students among the undergraduates who might have profited by his teaching were by college directors of study kept away from his class-room, as they were in earlier days held back from the lectures of Max Müller. Bywater published in 1880 a remarkable piece of research and discovery relating to the fragments of the Greek philosopher Heracleitus, which led to his election as corresponding member of the Royal Academy of Sciences of Berlin. He devoted many years to the criticism of the text of the "Ethics" and the "Poetics" of Aristotle, and in 1899 the Clarendon Press published his *magnum opus*, containing his recension of the text of the "Poetics" with an introduction, translation, and commentary. But the young college tutors had the power of directing their pupils "not to waste their time" with listening to this great and original investigator, and, instead, to work up their Greek in the examination classes of the colleges; and they exercised it! Such is the mischievous result of the English university dry-rot—the examination system.

Only a month ago when my friend had temporarily rallied from the illness which has now ended fatally, he discoursed to me in his characteristically cautious yet vigorous style of German (more especially Prussian) arrogance and intrigue and the boasted "Kultur" of the Germans. He said that the quality of their abundant work, never very high, had deteriorated since 1870, and contrasted their grasping and pretentious attitude at the International Conference of Academies in Vienna, where he represented the British Academy, with the charm and refinement of the leading Austrian delegate, Prof. Suess, the geologist, now also gone from us, who, he declared, justified his name by the sweetness of both his nature and his behaviour. E. RAY LANKESTER.

SCIENCE IN WARFARE.

WE reprint from the *Daily Mail* of December 18 a communication to that journal from a Belgian man of science showing how the Germans are utilising science for their operations in the newly conquered region in Belgium.

Here is a great lesson for us, for our Government cares too little for the nation's need for

science, which is as important for peace as for war purposes.

METEOROLOGY AND THE SCARBOROUGH RAID.

It is by no means surprising that for their raid on the three British coast towns the Germans should have profited so accurately by climatic conditions. When they first entered Belgium their army corps were immediately followed by the full staff of their observatories. On August 16 the astronomers and meteorologists attached to the Aix-la-Chapelle army corps took up their quarters at Liège, and on August 25 they were all at the Brussels Observatory at Uccle, where, on September 1, they were replaced by astronomers and meteorologists from Berlin.

Immediately on arriving at the Brussels Observatory the Germans turned out the Belgian staff. They made use of the Belgian instruments but supplemented them by the very up-to-date instruments they had brought from Berlin. On September 3 they began hunting for a Belgian hydrogen factory where they could obtain hydrogen for filling their testing balloons, by means of which they make their observations for predicting fogs. They used these balloons for forecasting the weather, particularly for the great German attack on Antwerp.

There is abundant evidence that the German men of science followed the same course with regard to the German raid on Scarborough, Hartlepool, and Whitby. They are admirably equipped for forecasting fog forty-eight hours ahead wherever they are. The German Army meteorological stations have certainly been transferred to Ostend and Zeebrugge. They may not be as important as submarines, but these observation stations can render almost as effective aid in Germany's work of destruction as these engines.

NOTES.

M. C. E. GUILLAUME, the director of the Bureau des Poids et Mesures at the Pavillon de Breteuil, Sèvres, has made it known that the Institute of France has started a hospital, using for the purpose the funds at its disposal, and the voluntary contributions of its members. In Great Britain there are about thirty Associés Etrangers and correspondants of the institute, who have been notified of the action of the institute, and they have responded generously to the appeal of their French colleagues.

WE learn from *Science* of the death at sixty-four years of age of Dr. D. E. Salmon, chief of the U.S. Bureau of Animal Industry from 1884 to 1906.

WE regret to announce the death, at seventy-one years of age, of Mr. A. R. Hunt, of Torquay, fellow of the Geological and Linnean Societies.

WE regret to see the announcement of the death on November 10, at seventy-five years of age, of Prof. N. C. Dunér, secretary of the Swedish Royal Society of Science, Upsala, associate of the Royal Astronomical Society, and author of astronomical works of prime importance.

IT is announced that, owing to continued ill-health, Dr. E. F. Bashford has resigned the post of general superintendent of the Imperial Cancer Research Fund, which he has held for the past eight years, and that his resignation has been accepted by the executive committee.

THE Royal Geographical Society has arranged two lectures to young people for the new year. On January 4, Mr. C. Carus-Wilson will lecture on the earth's unstable crust; and on January 8 the Rev. T. T. Norgate will take as his subject the theatres of war, illustrated. The meetings will be held in the Kensington Town Hall, High Street, Kensington, at 3.30 p.m. Application for tickets should be made to the chief clerk, Royal Geographical Society, Kensington Gore, S.W.

AT the fifth annual general meeting of the Society of Engineers (Incorporated), held on Monday, December 14, the awards of premiums made in respect of papers published in the journal of the society during 1914 were announced as follows:—The president's gold medal to Mr. A. S. E. Ackermann for his paper on the utilisation of solar energy; the Bessemer premium, value 5*l.* 5*s.*, to Mr. A. S. Buckle for his paper on cylinder bridge foundations in the East; the Clarke premium, value 5*l.* 5*s.*, to Mr. S. M. Dodington for his paper on mechanical appliances for the painless killing of animals; the premium, value 3*l.* 3*s.*, for members of affiliated societies, to Mr. R. H. Cunningham (Crystal Palace Engineering School) for his paper on irrigation in India; a society's premium, value 2*l.* 2*s.*, *to* Mr. James Tonge for his paper on uses of the hydraulic mining cartridge. Mr. Norman Scorgie was elected president of the society for 1915.

THE Royal Institution has circulated an illustrated brochure which explains for popular purposes the nature and objects of the institution. The institution was established under a charter of George III. in 1800, and enlarged and confirmed by an Act of Parliament in 1810. The objects of the foundation are "to prosecute scientific and literary research; to illustrate and diffuse the principles of inductive and experimental science; to promote social intercourse among lovers of science, men and women; and to afford them opportunities for collective and individual study." It is not necessary to insist upon the value to the world of the scientific work accomplished in the laboratories of the Royal Institution, when the names of a few of the great men who have worked there are recalled: Davy, Faraday, Tyndall, to say nothing of living men of science. The hope may be expressed that there will be no diminution of the usefulness and popularity of the institution in view of the war, but that its influence may become increasingly powerful as the years pass.

A DISTINGUISHED traveller and servant of the Empire has passed away in Archibald Ross Colquhoun, who died on December 18. He was born in 1848, and his earliest civil service was in the Indian police. From this he passed to the public works department, and then became secretary to a Government mission to Siam, and the Siamese Shan States. Later he was Deputy Commissioner of Upper Burma, but before this, in 1881–82, he made an important journey from Canton to Bhamo, investigating the possibilities for a Burma-Chinese railway route, and also acted as a special correspondent in the French war in Tongking (1883–84). Afterwards, having left Government ser-

vice in the East, he came into contact with Cecil Rhodes, served with the South African pioneer force, and became administrator of Mashonaland in 1890. In later years he travelled extensively and wrote much on South Africa, on the Far East, on the Pacific and the Panama Canal schemes, and on other topics. Some of his books are important contributions to the study of great political questions, such as "The Key of the Pacific" (on the Panama Canal routes), "China in Transformation," "The Mastery of the Pacific," and "The Afrikander Land." He was closely associated with the work of the Royal Colonial Institute, and was editor of its journal, and among various honours he received the gold medal of the Royal Geographical Society.

THE organised methods employed by Germany in commerce, and the means necessary to meet them successfully, were referred to by Sir William Ramsay in an article contributed by him to NATURE of November 12 (p. 275). Sir William deals with the same subject in further detail in a paper just issued by the Institute of Industry and Commerce (Aldwych Site, Strand, W.C.) The German military organisation has its counterpart in their commercial organisation; there exists an Imperial Council the proceedings of which are kept quiet, but which takes into consideration all obtainable statistics, and so far as possible legislates, or endeavours to legislate, on the basis of these statistics. Where fiscal duties are found to be required, such a council puts them on; where there is an advantage in taking them off, they are removed. Where cheap transit is possible they give it; for the railways are the property of the State. In referring to these matters at the annual meeting of the Society of Chemical Industry in 1903, Sir William Ramsay said:—"Is it to be expected that any country can fight such a combination as that without adopting, at all events, something of their methods, or without studying their methods, and without combining together, if not to imitate them, at least to thwart them? There is a military campaign against us, and we must defend ourselves." Sir William points out that it will be necessary, if the future German State is allowed to retain the power of waging an industrial war, to combat it by the action of the organised British nation, that is, by the State. Once that conquest is achieved, we should do well to remember that commerce should be co-operative and not competitive; that it is to our interest not only that we ourselves should prosper, but that others should also prosper; that, indeed, our own prosperity is bound up in the prosperity of our fellow-creatures.

THE Philadelphia meeting of the American Association for the Advancement of Science will open on Monday, December 28, when the retiring president, Prof. E. B. Wilson, of Columbia University, will introduce the president of the meeting, Dr. C. W. Eliot, of Harvard. Addresses of welcome by the provost and the governor-elect will be replied to by President Eliot, after which retiring President Wilson will deliver his address on "Some Aspects of Progress in Modern Zoology." There will be two public lectures, complimentary to the citizens of Philadelphia and vicinity, one on Tuesday night, at 8 o'clock, being by Dr. D. C. Miller, "The Science of Musical Sounds." On Wednesday night, at 8 o'clock, Dr. W. H. Nichols will lecture on "The War and the Chemical Industry." The titles of the addresses by the retiring presidents of the sections are as follows:—*Physics*: Recent evidence for the existence of the nucleus atom, A. D. Cole; *Botany*: The economic trend of botany, H. C. Cowles; *Anthropology and Psychology*: The function and test of definition and method in psychology, W. B. Pillsbury; *Mathematics and Astronomy*: The object of astronomical and mathematical research, F. Schlesinger; *Agriculture*: The place of research and of publicity in the forthcoming country life development, L. H. Bailey; *Education*: The American rural school, P. P. Claxton; *Engineering*: Safety Engineering, O. P. Hood; *Geology and Geography*: The relief of our Pacific coast, J. S. Diller; *Physiology and Experimental Medicine*: The classification of nervous reactions, T. Hough; *Social and Economic Science*: Social and economic value of industrial museums, J. G. Wall; *Zoology*: The research work of the Tortugas Laboratory of the Carnegie Institution of Washington, A. G. Mayer; *Chemistry*: Fermentation, C. S. Alsberg.

AT a good old age—eighty-six—the famous Swiss guide, Melchior Anderegg, has passed to his rest. Born near Meiringen, at which place he died, he was bred and lived, except when undertaking some longer excursion, in the Oberland. He was introduced, if we remember rightly, to the Alpine fraternity by the late T. W. Hinchliff, who described, in his delightful "Summer Months among the Alps," excursions with him across the Strahlegg Pass in 1855 and up the Altels in the following year. Melchior's "great ascents" were rather more than twenty, for his employers, among whom we may number the Walkers, father, son, and daughter, A. W. Moore, H. B. George, F. Morsehead, C. E. Mathews, and Leslie Stephen, belonged to the old guard of Alpine climbers and did not consider the charms of an expedition enhanced by needless perils. The more notable of those ascents were Mont Blanc by the Aiguille and Dôme du Goûter, and by the more difficult route from the Brenva glacier; the Col de la Tour Noire, a most laborious pass, near the Aiguille d'Argentière, and the Roththal Sattel, one yet more dangerous, under the Jungfrau; the highest peak of the Grandes Jorasses, the Dent d'Hérens, the Parrot-Spitze of Monte Rosa and its culminating peak by a new route up the Grenz glacier, but probably there were very few of the more noted peaks and passes of the Alps with which Melchior was not acquainted. Besides this, he was an expert wood-carver, and small statues of friends from his chisel have more than once been exhibited in England. Melchior deservedly won the affection of all who had travelled in his company. He was one of nature's gentlemen, and the late C. E. Mathews, whose companion he had been for thirty-four years, truly says in his "Annals of Mont Blanc" that he was "perhaps the greatest all-round guide whom the love of mountaineering has ever produced. . . . It is with a peculiar pleasure and

pride that I record that I never heard him utter a word to which the gentlest woman could object, and that I have never found him unequal to any kind of emergency."

IN the *American Museum Journal* for October-November Mr. G. G. MacCurdy, under the title of "Palæolithic Art as Represented in the Collections of the American Museum of Natural History," describes a number of objects acquired in France in 1912 by Prof. H. F. Osborn and the author. Among the most interesting specimens are a series of the tallies, or *marques de chasses*, which have been interpreted as records of their "kills" by the Aurignacian hunters; a set of perforated teeth, and shells of the Middle Aurignacian period from the Abri Blanchard, Dordogne; a holed limestone fragment, of which the utility is uncertain, it may have been used as a weight; figures of a horse engraved on stone of the Upper Aurignacian period from Roches-de-Sergeac, Dordogne, and of a reindeer on bone from Limeuil.

THE custom of cross-cousin marriage in South India, recently discussed by Dr. W. H. R. Rivers, is further considered by Mr. F. J. Richards in the December issue of *Man*. He arrives at the conclusion that it is based on economic considerations, and, in particular, on the mode of transmission of family property. The Dravidian people follow the rule of matrilinear succession. They subsequently came under the influence of the intrusive Brahmanical culture, in which the rule of patrilinear succession is followed. The effect of this clash of rival cultures was the desire of the matrilinear community to secure the advantages of patrilinear transmission of the estate; that is to say, the natural desire of the father to provide for his offspring might be secured by insisting that a man should marry the daughter of his maternal uncle, of his paternal aunt, or of his sister. This arrangement would enable a matrilinear community to conform to the patrilinear system of inheritance without fear of dissipating the family property, which is dependent on inheritance on matrilinear lines. The present practice of cross-cousin marriage is thus a compromise between the Dravidian rule of succession through the mother and the Brahmanical rule of succession through the father.

NEARLY the whole of part 6 of the tenth volume of Records of the Indian Museum is devoted to an account of fresh-water and terrestrial oligochætous worms, mainly collected in northern India, with descriptions of a number of new species. The author, Dr. J. Stephenson, of the Lahore College, remarks that the most noteworthy item is the occurrence of *Microscolex phosphoreus* (a widely spread species, the original home of which was probably in temperate South America), near Peshawar, at a distance of 700 miles from the sea. Although the dispersal from its original home across the Atlantic and Indian Oceans was doubtless due to the prevalent westerly winds, transport by human agency seems the only explanation of its isolated occurrence in the heart of northern India.

THE *Aarsberetning* of the Bergen Museum for 1913 and the first half of 1914 records steady progress in all departments during the period under review, a satisfactory incident being the bequest of 7000 kr. for general purposes. Numerous additions to the exhibited series of mammals and birds were made, but, judging from some of the figures in the text, there appears room for much improvement in the method of taxidermy. Ocean-surveying and the work of biological stations were carried on with great energy, reports from no fewer than forty-three stations being quoted. The contour of the channels of many of the Norwegian fjords is illustrated by a transverse section of the Sognefjord, in which the sudden descent of the sides and the great depth of the middle are well shown.

DR. W. SØRENSEN has published in French an important paper (*Kgl. Danske Videnskab. Selskabs Forhandlinger*, 1914, No. 3), on the anatomy of the Solifugida, that remarkable order of Arachnida which has attracted many zoologists to its study and which formed the subject of a lengthy memoir by the late H. M. Bernard (Trans. Linn. Soc. Zool., 2 ser., vol. vi.). The author criticises Bernard's work with some severity, pointing out that the latter's belief in the poisonous nature of the Solifugida is unsupported by facts, and that the structures designated by him as "coxal glands" have no openings on the haunches of the foremost legs, but terminate on short processes situated on the dorsal aspect of the appendages of the second pair. These appendages are termed "mandibules" by Sørensen. Considering the anterior position of the excretory organs under discussion, Sørensen's comparison of them with the Malpighian tubes of insects, which are outgrowths of the hind-gut, must remain open to question.

IN a recent issue of the Bulletin of the Imperial Botanic Garden of Petrograd (vol. xiii., No. 4), G. A. Nadson describes a number of interesting sulphur bacteria from brackish water in the Gulf of Finland. Two of the forms described are peculiar from the fact that the cells contain in addition to stored sulphur a substance which readily decomposes into oxalic acid; these bacteria live in badly aerated mud, and by increasing the oxygen supply the oxalite-like substance was found to increase, and the accumulation of sulphur to diminish, and *vice versa*. A remarkable new genus of sulphur bacteria, called Thiosphærella, was discovered, which contained in its cells large quantities of a starch-like substance; the other forms described are new species of the genera Achromatium and Thiophysa.

IN a paper which appeared in the *Annals of Botany* (vol. xxviii., No. cxii.) and of which we have received a reprint, Mr. S. R. Price describes some results obtained in the study of plant cells by the method of dark-ground illumination, a method hitherto but little used in botanical work. The method often reveals new structural features and is useful in establishing the presence of particles which are difficult to see or which are unresolved in direct illumination, but is very restricted in application on account of the difficulty of selecting suitable material for examination. Some of the author's observations indicate possible lines of work rather than completed

results. For instance, it is generally recognised that protoplasm is a colloidal complex, apparently existing both in the hydrosol and hydrogel state, the two states being spontaneously reversible; the process of germination of fungus spores, followed by the dark-ground method, showed the gradual conversion of the gel contents of the spore into a hydrosol on absorption of water, and later a formation of a gel might occur again. The nucleus and chloroplasts are probably specialised parts of the plasma with a hydrogel structure, but only in favourable cases could the nucleus be studied. Particles and vesicular bodies (which the author terms "sap particles") were usually found in the cell-sap and showed a continuous Brownian movement; they usually increased in number with decreasing vitality of the cell.

THE problem of the dolomitisation of limestone has received an interesting contribution from Prof. R. C. Wallace, of the University of Manitoba (*Compte-rendu* of the twelfth International Geological Congress, 1914, p. 873). He regards the concentration of magnesium ions in the solution from which dolomite is precipitated as in many cases the determining factor. This concentration at moderate depths of sea-water may determine whether calcite or dolomite is stable; at a certain concentration of magnesium, calcite goes into solution and dolomite is deposited. In a solution in which calcite is stable, magnesium carbonate may be unstable, and may go into solution until the magnesium ions are sufficiently abundant to produce a precipitation of dolomite. In the case, again, of underground water bringing magnesium into a limestone, a solution may abruptly arise in which calcite is unstable and becomes replaced by dolomite. It will be seen that this view differs from the older one of the mere substitution of magnesium for part of the calcium present in a mass of calcium carbonate.

WE have received from Prof. Eredia a pamphlet entitled "The Organisation of the Service of Weather Predictions in Italy," reprinted from the *Rivista Meteorico-Agraria* (vol. xxxv., 50 pp.). An experimental system of weather telegrams was instituted in the Papal States from July to December, 1855, and the observations were forwarded to Padre Secchi for examination. His report of the experiment was favourable, but practically the commencement of the service dates from April, 1866, when observations were telegraphed to the central office at Florence. After the removal of the latter to Rome the service was frequently improved, under the direction of Prof. Tacchini, and the daily weather report has latterly again been considerably enlarged. The present director is Prof. L. Palazzo, whose name is well known to many of our readers by the interest he takes in geophysics generally. Prof. Eredia also gives a brief sketch of the origin of the weather service in Europe. With reference to this country he remarks that in 1860 the Astronomer Royal informed M. Le Verrier (Paris) of the proposed establishment of a service on our coasts, and requested an exchange of bulletins. This is strictly true, but it might be explained that the communication was in reply to an inquiry by M. Le Verrier, which would naturally have been referred to Admiral FitzRoy before being dealt with. The latter issued daily weather reports to newspapers from September 3, 1860, and storm warnings from February 5, 1861. It may be worth while to direct attention to two apparent slips in the last paragraph but one on p. 7 of Prof. Eredia's laborious and useful compilation (with reference to a storm on December 1–2, 1863): Islanda should read Irlanda, and M. Davy is quoted as director of the English service.

IN a review of Dr. Hobson's "Squaring the Circle" in the Bulletin of the American Mathematical Society for November, Prof. R. C. Archibald directs attention to the early use of the symbol π by William Oughtred (1574–1660) in his "Clavis Mathematica" of 1631 and in his "Theorematum in Libris Archimedes de Spheara et Cylindro Declaratio" (Oxford, 1652). Oughtred employs the symbols $\delta : \pi$ to represent the ratio of the semidiameter to the semiperiphery of the circle, although he does not use the symbol π separately. He states specifically that $\pi R/\delta$ is the semiperiphery of a circle of radius R. Prof. Archibald further directs attention to references to squaring the circle in the Birds of Aristophanes (produced 414 B.C.), lines 1004–5, and in the last canto of Dante's "Paradiso" (canto 33, lines 133–5, in Cary's translation), and he points out that Longfellow, in his translation, gives "to square the circle" as the equivalent of the Italian "Misurar lo cerchio."

IN an article on "The Conic as a Space Element," in the Transactions of the American Mathematical Society, xv., 4, Mr. Roger A. Johnson develops a system of co-ordinates for the conic in three dimension space analogues to the line co-ordinates of Plücker, by treating the conic as a degenerate envelope. It is interesting to note that the problem of the conic in space has been studied for the last sixty years, and that in 1908 the Belgian Royal Academy announced the offer of a prize for a discussion of the subject. It may, however, be pointed out that the problem of the aeroplane in space is at the present time of a far more urgent character, and that the most pressing need is for pure mathematicians who find no difficulty in dealing with cumbersome formulæ as abstract as those which occur in connection with these harmless but unprofitable conics. Still, it is interesting to learn that the totality of conics of a T_4 that touch two fixed planes, the intersection of which does not meet the axis of the T_4, constitute a T_2 of the most general type.

OUR ASTRONOMICAL COLUMN.

THE APPROACHING MAXIMUM OF *o* CETI.—According to prediction, *o* Ceti or Mira will be at its maximum brightness on February 11 next, but it should be noted that both the star's period and brightness are not always the same at each return to its full brilliancy. As the star remains at its maximum brightness (2·0 mag.) for about fourteen days, it will be at a maximum on February 4 (approx.). At the present time it is a conspicuous ruddy object in a 4-in. telescope (mag. about 6·0), and its spectrum discloses the strikingly brilliant flutings and the bright hydrogen

lines. The variable is best situated for observation in the earlier part of the evening, and the following is its position :—

R.A.	Dec.
2h. 15m. 3s. ...	-3° 21′

THE ANTWERP ASTRONOMICAL SOCIETY.—In this column references have been taken from time to time from the *Gazette Astronomique*, which was a monthly bulletin of the Antwerp Astronomical Society. The last issue (No. 81) appeared in the beginning of September, when the investment of Antwerp had already commenced. A certain number of the members of this society have taken refuge in this country, and many of their British friends have suggested the idea of continuing the publication of this bulletin in London. Many of the latter have already made an effort to solve the financial part of the scheme, and it is due to their initiative that General J. Lerissen (president) and M. Felix de Roy (hon. sec.), on behalf of the society, have issued a circular asking others to contribute. If sufficient support is forthcoming it it proposed to issue the bulletin in both French and English. It will contain, besides notes of observations and of scientific articles, ephemeral notes, reviews of publications likely to interest amateurs, and place at their disposal the working data provided by professional astronomers. Those wishing to help may obtain further information from the hon. secretary at 29 Stamford Street, London, S.E.

SOME RESULTS OF THE RECENT ECLIPSE EXPEDITIONS.—Last week reference was made to the results of the Spanish eclipse expedition to the Crimea during August last, and attention was directed to a red coronal radiation at λ 6373·87, which was discovered by M. Carrasco on his photographic plates. This radiation is a new addition to the spectrum of the corona, and, like some other coronal radiations, seems to vary in intensity with the state of solar activity at the time of eclipses. M. Iniguez, the director of the Madrid Observatory, has just forwarded an enlargement (paper) of the region, between $H\alpha$ and D_3, the original of which was taken 13 sec. after second contact, and exposed for 10 sec. This print shows in the first place the sharpness of the images of the arcs, and in the second the clear and prominent arc due to the new coronal radiation. The wave-length is given as $6373{\cdot}87 \pm 0{\cdot}04$ A. units. In the *Comptes rendus* (vol. clix., No. 23) for December 7 M. Deslandres presents a communication by MM. J. Bosler and H. G. Block with reference to the results of the Meudon eclipse expedition to Strömsund (Sweden). The note is restricted to the results of one part of their programme, namely, the spectrum of the corona. The continuous spectrum of the corona was perfectly regular, and indicated no signs of flutings or Fraunhofer lines, but only gradations due to the sensitiveness of the photographic plate. The well-known green radiation at λ 5303·7 was entirely absent. In the red part of the spectrum a brilliant and intense new radiation appeared. The wave-length is given as 6374·5 Å. units (to 0·2 A.U. nearly), and agrees well with that determined by the Spanish observers.

GEMINID METEORIC SHOWER, 1914.—Mr. Denning writes :—"The weather greatly interfered with observations this year. The sky was, however, favourable on December 8, and a watch was kept at Bristol, but there were few Geminids. These exhibited a well-defined radiant at $106^\circ + 31^\circ$. The following nights were cloudy and wet, but on December 12 the sky cleared for a few minutes about 10.35, and six Geminids were noticed. Later, through openings in the clouds, further meteors were recorded, all from the same shower. There were two very distinct radiants, viz., at $109^\circ + 33^\circ$ and $119^\circ + 32^\circ$. They appeared to be about equally active. In 1885 and 1892 the same pair of radiants were very rich, and seemed to prove that the shower is a double one. From a comparison of all my observations of the chief system near α Geminorum I conclude the radiant is distinctly a moving one like the Perseids. It seems visible during three weeks from November 25 to December 16, with a maximum on about December 12. This year I believe the display to have been a very rich one on that date, giving nearly forty meteors an hour, and I await observations from places where atmospheric conditions were more favourable than at Bristol. My positions for the radiant are as follow near the maximum :—

Dec. 5	...	$102^\circ + 33^\circ$	Dec. 11	...	$109^\circ + 33^\circ$
6	...	$104^\circ + 33^\circ$	12	...	$110^\circ + 32^\circ$
7	...	$105^\circ + 33^\circ$	13	...	$112^\circ + 32^\circ$
8	...	$106^\circ + 33^\circ$	14	...	$114^\circ + 32^\circ$
9	...	$107^\circ + 33^\circ$	15	...	$115^\circ + 32^\circ$
10	...	$108^\circ + 33^\circ$	16	...	$116^\circ + 32^\circ$

"From my observations in 1885 there is strong evidence that the companion shower at about $119^\circ + 32^\circ$ also moves eastwards, but more data are required. Our weather is rarely suitable at this period of the year."

KASHMIR AS A SITE FOR A SOLAR OBSERVATORY.—Bulletin No. 42 of the Kodaikanal Observatory contains a very interesting report by Mr. J. Evershed on the seeing condition as studied by him in the valley of Kashmir. It may be remembered that last year he reported very favourably about this valley for solar observations during the months of August and October, and, contrary to all previous experience in other localities, he noticed that the definition of the sun was found to be of the best quality throughout the day and on all days that observations were made, there being apparently no marked variations depending on the height of the sun above the horizon, nor upon the type of weather prevailing. In order to test the conditions in this locality during other months of the year, and to make more critical observations both photographic and visual with larger instruments, an expedition was sanctioned by Government in April of the present year, and this report sums up the results obtained during the months of May, June, and July. A scheme of operations was arranged so that comparisons at Kashmir could be made with the experiences at Kodaikanal. For a detailed account of the results the reader must be referred to Mr. Evershed's report, but the following brief statement of the main result is as follows :—Taking a scale of seeing as very bad definition 1, bad 2, fairly good 3, good 4, and so perfect that no tremors can be perceived in the 8-in. solar image projected on a screen attached to a portable instrument as 5, then it may be stated approximately that the mean seeing at Kodaikanal for the whole year would hardly reach 2, whilst that in Kashmir valley would probably exceed 3·9. The number of days when the seeing ranged between 4 and 5 would be very much larger in Kashmir than in Kodaikanal. The photographic work was found entirely to confirm the visual observation, and, as he states, "indicates the enormous possibilities of progress in the study of solar physics which an observing station in Kashmir Valley would present." As the chief factor in solar research is the quality of the "seeing," the importance of the above conclusion cannot be put aside.

COLLIERY EXPLOSIONS AND COAL-DUST.

UNDER the title of "Great Colliery Explosions and their Means of Prevention" (London: The *Colliery Guardian* Co., Ltd.), Dr. W. Galloway has collected into a small volume a number of papers contributed by him between the years 1872 and 1908 to various publications; these were so scattered that their logical sequence was not always easy to trace, and they gain greatly by being presented in their order and gathered within the covers of a small volume.

The first two papers deal with the connection between colliery explosions and the state of the barometer, and showed, what no one probably doubts to-day, that there is a greater danger of firedamp explosions with a falling barometer than under any other atmospheric conditions. The next paper gives an account of a series of experiments which demonstrated that a violent atmospheric concussion, such as that produced by a shot, can force flame through the gauze of a safety-lamp, so that a lamp, which would be quite safe in a quiescent explosive atmosphere, may initiate an explosion if the same atmosphere is violently disturbed. This fact, like those above referred to, is a matter of such common knowledge to-day amongst miners that they are apt to forget that there ever was a time when it was not known, and it is as well that they should have at hand a reminder as to who it was that first discovered this very important fact.

The remaining papers are perhaps of higher interest than those already mentioned, as they all deal with the part that coal-dust plays in propagating colliery explosions. For a long time the coal-dust danger was either neglected or flatly denied even by the highest mining authorities, and Dr. Galloway deserves the greatest credit for the part he has played in forcing its recognition upon the mining community. It is evident from a perusal of the papers here collected that it was only gradually that the gravity of the danger of coal-dust explosions impressed itself upon Dr. Galloway himself, and that it was quite a long time before he could convince himself that coal-dust was dangerous in the entire absence of fire-damp. Thus in 1876 he disagrees with the opinions expressed by a French engineer, M. Vital, who held that finely divided coal-dust may of itself alone (*i.e.* without fire-damp) give rise to disasters, and he states his definite conclusion that "*a mixture of air and coal-dust is not inflammable at ordinary pressure and temperature*" (p. 57), and goes on to show that when as little as 0·892 per cent. by volume of fire-damp is added the mixture becomes inflammable. Already at this date, however, Dr. Galloway advocated the watering of the roadways in collieries so as to keep down the dust. In 1879 Dr. Galloway had apparently modified his views to some extent, for he then wrote: "It is probable, moreover, that some kinds of coal-dust require less fire-damp than others to render their mixture with air inflammable; and it is conceivable that still other kinds may form inflammable mixtures with pure air" (p. 73). In his first paper in 1882 he still seems to consider the presence of a minute proportion of fire-damp, too small to be detected by a safety-lamp in the ordinary way, which he calls the "*latent*" fire-damp, indispensable to the formation of a dust explosion, but he continued to experiment, and in his second 1882 paper he wrote that his experiments "show conclusively, I think, that fire-damp is altogether unnecessary, when the scale on which the experiments are made is large enough" (p. 111). It is important to note that Dr. Galloway reached this conclusion after six years of continuous experiments, in direct contradiction to his earlier views on the subject, and this fact should of itself have inspired confidence in the matured opinions that he expressed.

The remaining papers in this volume are devoted to an elaboration of this coal-dust theory, but though of undoubted importance, they are less so than the above-quoted series in which Dr. Galloway showed by direct experiment that coal-dust and air form an explosive mixture even in the absence of inflammable gas, and the fact that he was the first to furnish experimental proof of this has established his reputation as an original, accurate and painstaking investigator of colliery explosions; this little volume shows clearly enough the extent to which he has laid the coal-mining community not only of this but of all other countries under a deep debt of gratitude.

H. L.

THE EDUCATION IN LONDON OF REFUGEES FROM FOREIGN UNIVERSITIES.

A FEW weeks ago (NATURE, November 26) we gave an account of what is being done to establish an informal Belgian university at Cambridge, for students of the University of Louvain and other universities affected by existing military operations. Both the Universities of Oxford and Cambridge have, so far as we understand, offered a generous hospitality on a large scale to both the staff and students of Belgium universities, but while affording them every facility for quiet study, have not attempted to bring them systematically within their own system. The University of London, on the other hand, is putting at the service of refugee students not merely the teaching facilities of its two incorporated colleges, but also the right to enter its degree courses and to obtain its degrees on exceptionally favourable terms. It is allowing a partial or total remission of fees both for full teaching courses in expensive laboratory subjects, such as engineering and preliminary and intermediate medicine, and for entrance to examinations. It has further made special concessions as to both the matriculation and intermediate examinations, which will make it possible for the students to answer questions in French, and have their knowledge tested on the lines of education they have previously received in their own universities. If the Privy Council approve of the Amendment of Statutes which the Senate of the University is referring to them, a clever student who has come over to London from Belgian or French universities this autumn, will be able to pass the examinations in lieu of matriculation and intermediate by the early spring, and enter at once on his final course.

This interesting experiment to enable deserving students of the allied nations to obtain actual English degrees entails extraordinarily severe work on the administrative and teaching staff of the colleges. King's College has seventy-four of such students, University College sixty-seven, and the Imperial College a certain number. None of them knew English to start with, and special classes have had to be arranged to teach it them. The courses in foreign universities differ greatly from those of English universities, as well as from each other, and infinite care has had to be taken to discover the exact stage in each subject which a given student has reached. In engineering, for instance, in which King's College alone has forty-two such students, the standard of applied mathematics is much lower in the earlier stages in Belgium than in England, while that in pure mathematics is higher. Even allowing for the assistance of the Belgian professors who are being called into council, it is not above the mark to say that the time taken over each refugee student is as much as that over ten English students. Apart from the academic work, the hospitality which the senior common rooms of University and King's Colleges

have extended to these students, many of whom are for the present quite without funds, cannot be left out of account. In regard to the Jewish students, who form a large proportion of the whole, and who are mostly Russian subjects studying at Liège or Ghent, valuable help has been received from the Central Jewish Committee.

This effort, however great the tax it imposes on the colleges, is worth making. It will enable Belgians who are medically unfit to go on active service, and Russians whose military service begins at the end of their university career, to obtain their professional qualifications during the war, and thus fill the depleted ranks of doctors and engineers in their respective countries. It will also spread a knowledge of English university education on the Continent, and not improbably make the University of London an international, as it is already an Imperial, centre of university education.

THE PRODUCTION AT WILL OF EITHER FUNGUS-GERMS, FLAGELLATE MONADS, OR AMŒBÆ FROM THE ULTIMATE SEGMENTS OF SMALL MASSES OF ZOOGLŒA.

AN illustrated article dealing with this question of the heterogenetic origin from small Zooglœa masses of Fungus-germs, Monads, or Amœbæ, written by me, appeared in NATURE of November 24, 1904. That article was prepared at short notice in consequence of a short letter on "Archebiosis and Heterogenesis," which appeared a fortnight previously, and at a time when I was not specially working at this subject. Of late I have been doing much work in this direction, and have made out many very important new points, and can now speak with more precision concerning the changes generally, and the modes of obtaining them.

My results were received with great scepticism, and no bacteriologist has been induced to attempt either to confirm or refute them. The possibility of "infection" has so dominated them, that they have refused to consider the question. Of late, however, three bacteriologists have accepted my request that they should allow me to demonstrate to them my position by their examination of actual specimens. This they did, separately, and as a result neither of them was able to doubt that the Fungus-germs, the Monads, and the Amœbæ were, in truth, derived from the ultimate segments of the Zooglœal masses; nor did they suggest that the very similar developmental changes to be seen in hundreds of Zooglœal masses taken from their respective scums could possibly be accounted for by "infection."

Only one of my friends had any interpretation to suggest in opposition to my own. He started the supposition that what appeared to be bacterial aggregates might "possibly," in spite of their appearance, not actually be of that nature. He suggested that, though taking the guise of bacteria, and though all were similar in appearance, they might nevertheless be some hitherto unknown progenitors of Fungus-germs, of Monads, and of Amœbæ which had aggregated as Zooglœal masses, and subsequently given rise to their respective products.

This wild supposition may, at all events, be taken as an indication that its author could not doubt the fact of the different products coming from the ultimate segments, or imagine that "infection" could account for what he had seen. It was started by one who was absolutely opposed to the very notion of heterogenesis. He was subsequently able to find absolutely no support for his "possibilities," and after a futile search frankly admitted that only bacterial Zooglœas were known, apart possibly from others of an algoid type.

The current notion among bacteriologists concerning the nature and mode of origin of Zooglœas is that adopted by R. Muir in the article, "Bacteriology," in the last edition of the "Encyclopædia Britannica" (vol. iii., p. 161), in which he says:—"The Zooglœa is now known to be a sort of resting condition of the Schizomycetes, the various elements being glued together, as it were, by their enormously swollen and diffluent cell-walls becoming contiguous."

But bacteriologists do not seem ever to have examined the small masses that form in the scum on the surface of a hay infusion. I have been unable to find any reference to them, or of processes of segmentation occurring in any other Zooglœas. I cannot think that those with which we are now concerned are formed in the manner above indicated. All the evidence seems rather to show that as the bacteria rapidly multiply they also excrete the jelly-like glœal material in which they are subsequently found to be imbedded.

Preparation of the Infusions.

One of the important new points recently ascertained is that I can prepare two small infusions at the same time from the same sample of hay, and by allowing one to infuse for three hours at a temperature of 90° F., can feel confident that in the course of three to five days the ultimate products of segmentation of the Zooglœas that form can be made to yield Monads or Amœbæ; while if the other is infused for the same time at 98° F. no Monads or Amœbæ will appear, and the ultimate Zooglœal segments, though formed, and very similar in appearance, will remain apparently stationary for eight to thirteen days, and then begin to show themselves as multitudes of brown Fungus-germs.

It is best to use comparatively new hay, and not that of the previous season. I take a small portion and having cut it into ½-in. lengths, place it in 2-oz. beakers to which water is added just sufficient to cover it. The proportion of the two I have found to be a little more than 30 grains to the ounce of water. As soon as the infusions have been made they are filtered through No. 0 Swedish paper (so as to exclude encysted Kolpodæ and the great majority of Fungus spores) into common one-ounce porcelain pots, until they are about half-full—the depth of the infusion being then only a little more than half an inch. The scum which ultimately forms will be thin, and therefore much more favourable for examination than if it had been thick and formed over a greater depth of infusion. The covers are replaced on the pots, and the dates and temperatures at which the infusions have been made are marked thereon. These covered pots are then mostly kept at room temperature, 62°–64° F.

Examination of the Scum or Pellicle.

The pots are not usually opened until two days have elapsed, as it would be only during the last twelve hours that any very distinct scum begins to form, and that a few very small Zooglœas may be found scattered through it. By the end of the third day the Zooglœas may be very numerous, and will be found to vary much in size and shape. An example illustrating a rather later stage is shown in Fig. 1, in which the little masses are seen to be extremely numerous. Many of these early Zooglœas already show primary processes of segmentation.

In order to examine the scum a small portion is taken up on the point of a scalpel and rotated off on to a drop of distilled water. If thereafter it should be desired to preserve the specimen some 5 per cent.

formalin is run in, and the cover glass is ringed. But where there are brown Fungus-germs it is better to let the specimen remain in water, as the formalin, and also glycerin, would speedily remove their characteristic colour.

When some of these first-formed small Zoogloeas are examined with a high power, it becomes obvious that they are simple aggregates of bacteria, such as may be seen in Figs. 2, A, and 3. Further, just the same kind of bacteria are to be seen within them as in the scum immediately around; and the bacteria from the scum of the infusion prepared at 90° F. do not differ morphologically from those of the scum on the infusion prepared at 98° F.

It must come to be a question whether the different products ultimately yielded by the two sets of Zoogloeas can in part be attributed (*a*) to the fact that the constituent bacteria are actually different in the two cases, or (*b*) to the fact that the slightly different (and far from lethal) temperatures at which the two infusions have been prepared, have sufficed to modify the physiological attributes of the same set of bacteria. The latter seems to me to be by far the more probable explanation, looking in part to the seeming morphological identity, and also to the possi-

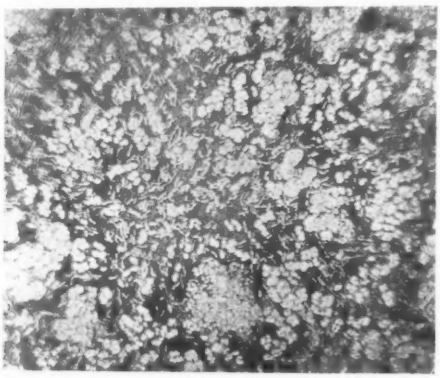

FIG. 1.—×200.

bility that the exposure to the higher temperature of 98° F. for three hours may have somewhat degraded the molecular structure of the bacteria, so that these particular aggregates are only eventually capable of yielding vegetal rather than animal products, and that, too, after rather more than twice as long a period. Important facts in support of this conclusion will be reported later on.

It is, moreover, a very remarkable circumstance that almost until the ultimate products of segmentation are reached there seems to be no means of distinguishing by mere microscopical examination whether the Zoogloeal masses are going to yield brown Fungus-germs, Monads, or Amœbæ. As they grow and develop, they all tend to segment into smaller and smaller portions; and after a time the constituent bacteria become hidden owing to molecular changes in the gloeal material. These are also shown by the segments becoming glistening and more refractive, and at the same time more receptive of logwood and other stains.

Conversion of Ultimate Segments of Zoogloeas into Brown Fungus-Germs.

In Figs. 2–5 are to be seen portions of some of the Zoogloeas from pots containing an infusion that had been prepared at 98° F., and the scum on which subsequently yielded only Fungus-germs.

Fig. 2, A, shows a portion of one of the Zoogloeas at an early stage, in which the bacteria are still very

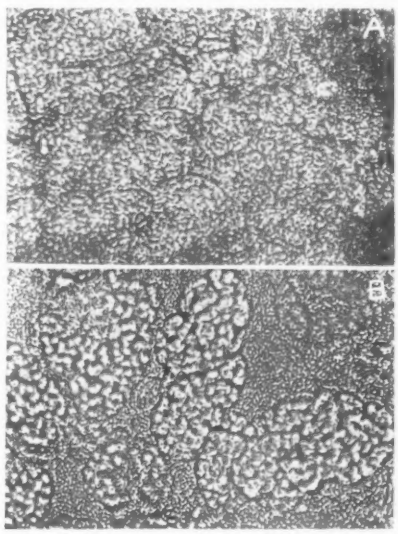

FIG. 2.—×500.

distinct, though later they often tend to become more or less enlarged and altered in appearance. In Fig. 2, B, a later stage is shown in which much segmentation has taken place, where the bacteria are no longer recognisable, and the segments have assumed the glistening appearance already referred to

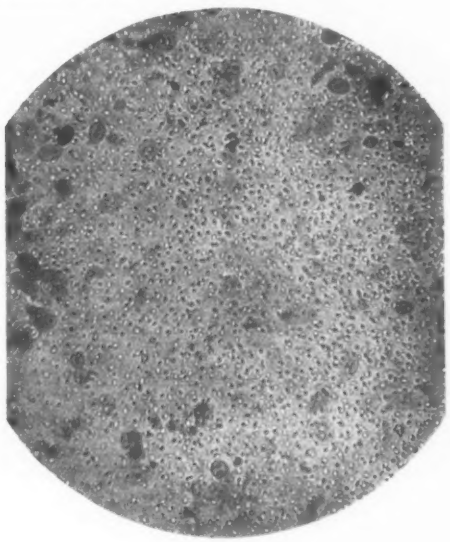

FIG. 3.—×500.

The date at which the change into brown Fungus-germs begins is subject to considerable variation, but this colour is rarely seen before the eighth or after the thirteenth day—the time needed being in part

dependent upon the temperatures at which the pots are kept.[1]

The actual mode of production of the Fungus-germs from the bacterial aggregates may be seen in Figs. 3–5. A portion of a Zooglœa lightly stained with *C. fuchsine* is shown in Fig. 3, in which the bacteria are remarkably distinct, and where here and there they are becoming enclosed within distinct cell-walls. We see, in fact, a free cell-formation going on, in which the bacteria become the nuclei, and these nuclei undergoing division. Fig. 4 shows other stained specimens illustrating the mode in which segmentation progresses from multibacterial aggregates in A to multinuclear masses in B, which lead on in C to separate ultimate products in the form of nucleated Fungus-germs.

In Fig. 5 we have to do with unstained specimens gradually assuming a brown colour. In A the three pale masses show early stages in which the Fungus-germs are forming, *in situ*, in fairly large segments; while the dark masses around are aggregates of

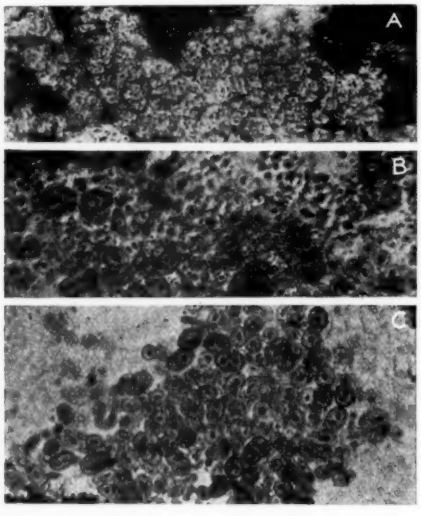

FIG. 4.—×500.

brown, fully formed Fungus-germs. In B we have a more ill-defined Zooglœa, in which careful examination will reveal portions becoming more and more distinct, until they end with groups of large well-defined brown Fungus-germs.

We have here then a direct free formation of cells, the existence of which has so long been doubted, where bacteria constitute the nuclei, and the altered glœal material the remaining portions of the cell-protoplasm. What is so plainly to be made out in Figs. 3 and 4 seems generally to occur when Fungus-germs are formed in and from Zooglœas; and the mode in which segmentation is so clearly shown to progress in Fig. 4 probably holds good for all other Zooglœas, even when the ultimate products are of a wholly different order

In all cases the Fungus-germs produced in the manner I have shown, though they multiply to some extent so as to form small heaps or short chains, remain as such for very many days, and require to be much coaxed in order to undergo further development with production of hyphæ.

Conversion of Ultimate Segments of Zoogloeas into Flagellate Monads.

Where the infusion has been prepared for three hours at 90° instead of at 98° F. the Zooglœas which form present no difference in appearance and in mode of segmentation from what has been represented in Fig. 2.

There is, however, this remarkable difference, that such masses never assume a brown colour, and their ultimate products of segmentation begin to be visibly transformed in three or four rather than in from eight to thirteen days, and then they reveal themselves as rapidly increasing swarms of flagellate Monads.

These ultimate segments appear at first as little spherical, motionless bodies, such as are shown dispersed at the edge of a portion of scum in Fig. 6, A, and also aggregated as ultimate products of a small

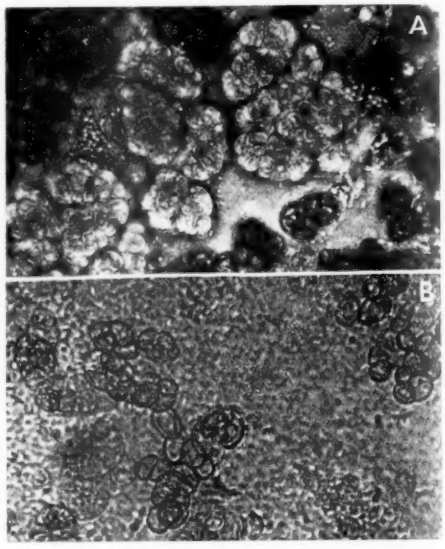

FIG. 5.—×700.

mass in 6, B, though they are there somewhat obscured by a few overlying bacteria. A smaller aggregate of motionless units is represented above, while below, before the running in of some formalin solution, some of the bodies shown were active Monads.

These Monads always contain a few granules, such as are shown in 6, C, in the lower body on the right, and a quite small nucleus is also frequently recognisable in such early units. Slight variations in size and shape of the Monads are met with from different samples of hay, just as different kinds of Fungus-germs are also produced. They have generally two flagella, though one of those that I succeeded in photographing (Fig. 6, C) has three. I have never previously been able to get any tolerable photograph of these Monads; this time I was to some extent successful with the aid of eosin. All other dyes or preservatives have proved useless, owing to the extremely delicate structure of the Monads. At times when a slide has been under examination for a rather long time, some of the Monads have become quiescent, and then I have often been able to recognise a contracting

[1] Where the infusion has been made at a higher temperature, such as 100°–102° F., the appearance of the brown Fungus-germs may be still further delayed. What I have to say in this communication refers only to the products from the Zooglœas that may be found within the first fourteen days.

vacuole near the posterior extremity, rhythmically opening, and sharply closing about every twenty seconds.

Flagella, nuclei, and contracting vacuoles appearing in animal units independently of heredity, and as derivatives from chance bacterial aggregates, such facts now revealed supply us with marvels far surpassing what was previously seen in the way of origin of nuclei and free-cell formation during the genesis of brown Fungus-germs—though even these latter changes give the death-blow to Virchow's celebrated dictum, *omnis cellula e cellula*.

Conversion of Ultimate Segments of Zooglœas into Amœbæ.

This is perhaps a more interesting and remarkable transformation than either of the other two. When I last wrote on this subject I was altogether unaware of the nature of the differential conditions favouring the conversion into Amœbæ rather than into Monads. Now I have found that this production of Amœbæ can almost always be brought about by preparing the infusion at a temperature of 85°, rather than at

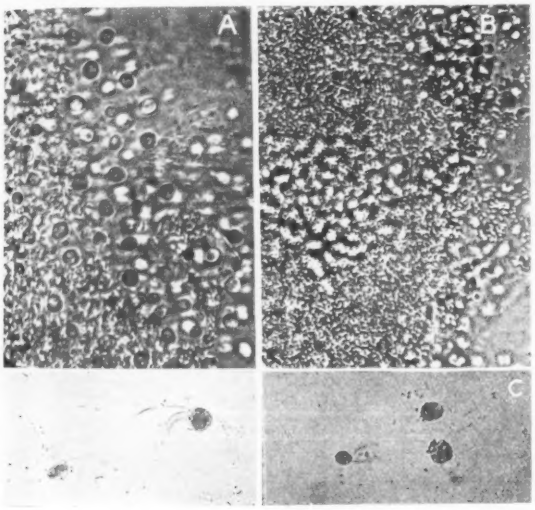

FIG. 6.—A and B×500; C×700.

90° F., and by subsequently keeping the pots at a temperature rather higher than that generally adopted. Sometimes, however, in such trials both Monads and Amœbæ are produced simultaneously.

The procedure mentioned generally leads to the production of a very large number of Zooglœas, which have essentially the same bacterial constitution and mode of segmentation as have been met with in the other Zooglœas, and which are represented in Fig. 2.

The transformed ultimate products of segmentation begin, as in the last case, to show themselves on or about the third day, while by the fourth and fifth days actual myriads of minute Amœbæ are to be seen in every portion of the scum taken up for examination, so that at last no traces of the very numerous Zooglœas from which they have been derived are to be found. These Amœbæ often at first have a single flagellum.

One of the final stages in such a resolution is shown in Fig 7, A, where the ultimate units, which are mixed with a few actual Amœbæ, are still pretty closely aggregated. In a few of them quite small nuclei are shown, though these are much smaller than what are generally to be seen in embryo Fungus-germs just separated from a parent mass. The latter are also usually more ovoid, and have much more well-defined outlines.

A few of the myriads of Amœbæ as they appear in the formalin solution are represented in 7, B. The great crowds of Amœbæ produced soon lead to conditions unfavourable for their existence, so that after another two days they will generally be found to have become encysted, as represented in Fig. 7, C.

Whether altered bacteria again furnish the nuclei of the finished products cannot be positively stated. The nuclei are always rather large in embryo Amœbæ, and distinctly larger than in young Monads.

A point of great importance in reference to what I have said concerning the comparatively sudden appearance of great swarms of small Amœbæ is the fact that such organisms can only rarely be seen to undergo division when immersed in fluids. I have long expressed this view, and now find it supported

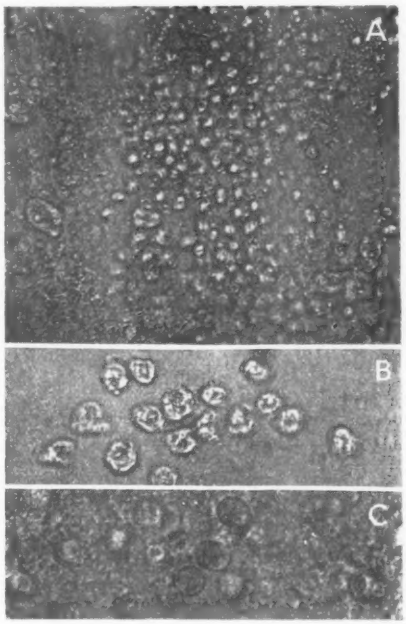

FIG. 7.—×500.

by the latest workers on these organisms, namely, J. W. Cropper and A. H. Drew, in their recently published "Researches into Induced Cell-Reproduction in Amœbæ." The rapid appearance, therefore, shown to occur of myriads of minute Amœbæ would be quite inexplicable by ordinary processes.

In what has been said details have been given which will almost certainly lead, at will, to the production either of Fungus-germs, of Monads, or of Amœbæ. I have already expressed the opinion (p. 462) that we have not necessarily to do with different bacteria in these cases, but rather with the same bacteria differently modified by the prolonged, though comparatively slight, differences of temperature maintained during the production of the infusions.

The recent access of cold weather has enabled me to confirm this, and has, moreover, shown that the temperature at which the pots are kept is only a little less important than the variations in temperature at

which the infusions are prepared. I have found, for instance, that infusions prepared at 90° and 85° F. respectively, will no longer yield Monads or Amœbæ if the pots are from the first kept at a temperature of 50°–54° F. Then, in each case, as a rule, only brown Fungus-germs begin to appear after eight or more days, instead of the Monads or Amœbæ which would have appeared had the pots been kept at the higher temperatures previously indicated.

Here then we have the revelation of still more astounding facts, since it seems to be shown that Amœbæ, Monads, and Fungus-germs are actually interchangeable products, capable of being derived from similar bacterial aggregates, under the influence of slight but well-defined differences of temperature.

A Few New Details Concerning Some Tube Experiments.

In a previous communication to NATURE for January 22 of this year I gave some account of my experiments with saline solutions in sterilised tubes, tending to show that living matter is still appearing *de novo* on the surface of the earth, seeing that under the very restrictive conditions necessitated by these experiments there was abundant evidence to show that Bacteria, Torulæ, and simple Moulds have repeatedly come into existence.

I stated that my experiments had been repeated in Paris with positive results by Albert and Alexandre Mary. They not only obtained organisms from their tubes, but caused them to multiply in different culture media.[2] My experiments were also repeated in New York by Drs. Jonathan Wright and MacNeal. After some negative and some doubtful results, they succeeded last year, among a few other successes, in producing crowds of organisms in every one of a set of twelve tubes, containing colloidal silica and other materials which I had sent them. At first they felt strongly of opinion that the results obtained from the first of these tubes, in which, as they said, unquestionable organisms were found in "enormous numbers," must have been due to the pre-existence of organisms in the materials used. But after careful examination of the materials they found no support for this supposition, admitted that they could not take refuge in any other, and added, "we have no suggestion to make other than your interpretation, and, indeed, we desire to be entirely non-committal as yet."

These experiments were undertaken by Dr. Wright, as he told me in his first letter asking to be supplied with some of the actual materials used by me, in consequence of his "sincere desire to ascertain the truth"; but only a few weeks after they had found unmistakable confirmation of my results, I received a letter informing me that he and his colleague were not intending to pursue the investigation. One reason alleged for their relinquishment of the investigation at this particular juncture was their non-success, in the few, and only slightly varied, attempts made to cause the organisms to grow in culture media.

Dr. Wright has, however, been good enough to send me some of their notes and unopened tubes, and amongst them I have received and opened three of the twelve tubes in question. On examination the organisms contained in each of them have been similar to those found in the first tube, specimens of which had been sent to me. In others, opened in New York, I am told the organisms have also been similar.

In Fig. 8, A and B, two of the many larger organisms found by me are shown. They are of a kind new to me, not corresponding quite either with *Streptothrix* or *Crenothrix* to which they seem most allied. In Fig. 9, A, one of the numerous early forms of such an organism, is shown; while in Fig. 9, B, we have a highly magnified reproduction of one of the many small masses which were found, similar to one which is to be seen in Fig. 8, A. In this mass,

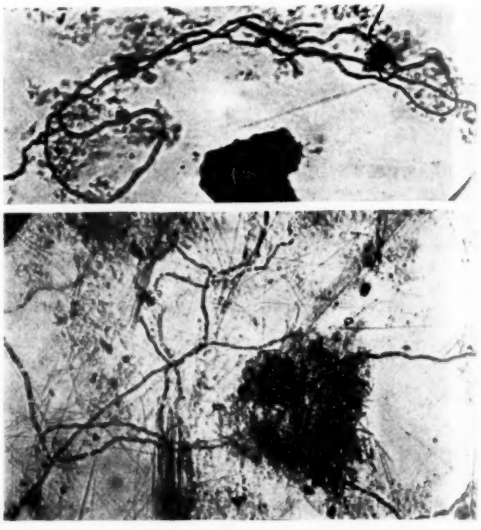

FIG. 8.—×350.

among crowds of bacilli, there seem to be also many embryonic forms of the large organism.

I handed the last of these tubes to Aubrey H. Drew,[3] as he kindly undertook to try to develop the organisms. He has been successful, with the aid

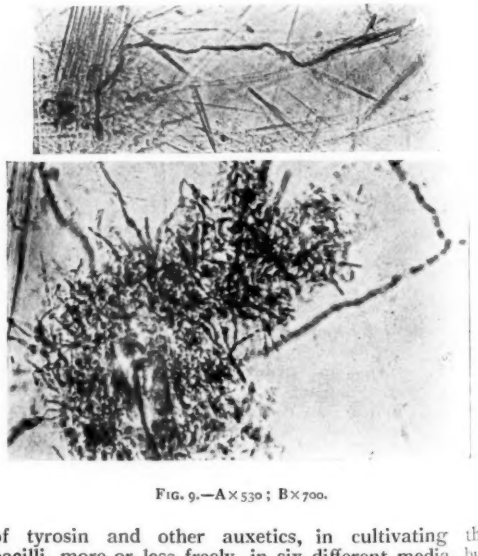

FIG. 9.—A×530; B×700.

of tyrosin and other auxetics, in cultivating the bacilli, more or less freely, in six different media, but not the large organism. The bacillus, too, seems to be strange; he has tested it in various ways and its

[2] See *Le Medecin* (Brussels), October 21, 1913, and January 15, 1914.

[3] Joint-author with Dr. J. W. Cropper of "Researches into Induced Cell-Reproduction." (Murray, 1914.)

behaviour, he tells me, is not in accord with any known form. He says: "It is large, 10 to 15 μ long, and shows a strong tendency in fluid cultures to grow into filaments, but I have not observed any branching." It is gram-positive, stains with difficulty, and "its most characteristic feature is a brilliant lemon yellow growth on auxietic agar."

I should like to refer to one other recent experience. In June 26–28, 1912, I prepared and sterilised six tubes containing a yellow solution composed of 3 drops of sodium silicate and 8 drops of liquor ferri pernetratis to the ounce of water. Five of these tubes were opened and their contents examined after periods ranging from six to nine months, and in each embryo Torulæ and other torula-like bodies, together with a few very minute mycelia of indeterminate types, are recorded by my notes to have been found. The sixth tube (No. 416) had been most of the time in the incubator, and was not opened till August 2 of this year—that is, more than two years after its preparation. Some previous experiences induced me to

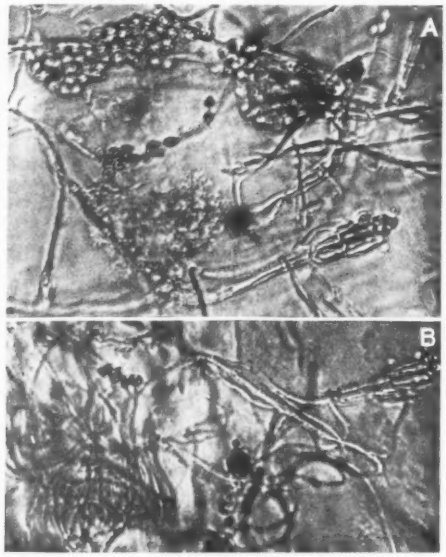

FIG. 10.—×700.

make such a trial. On opening the tube, in which there was only a very small amount of deposit, I obtained the whole of it in two dips with a pipette (the centrifuge used afterwards showed only a few shreds, granules, and minute glass splinters). The contents of the dips revealed many of the same torula-like bodies as had been found in the other tubes, and also "four masses of minute mycelium issuing from aggregates of minute spherical and ovoidal germs, together with granular matter, in part seemingly composed of typical cocci and short bacilli." With the Moulds, as shown in Fig. 10, A and B, there were masses of spherical spores with a central dot in each, together with small heads of fructification of Penicillium type bearing similar acrospores.

From a very similar solution contained in four other tubes, prepared on May 17–19, 1912, in three, which were opened at periods varying from seven to ten months, the spores and mycelium of a mould of Oospora type were found by myself and others. The fourth tube was kept for nearly seventeen months before it was opened, and two months before that date two obvious tufts of mould could be seen at the bottom of the tube, one of them nearly half an inch in diameter. When this tube was opened in Prof. Hewlett's laboratory, we saw that the growth was again a mass of Oospora [4] with the same characteristic spores as had been previously found. All this set of tubes had been exposed to light during the first six months, while the others had been in the incubator.

Concluding Remarks.

Many critics of my tube experiments have been incredulous either as to the organisms found in the tubes being really organisms, or else as to their being living and actually engendered within them. They found it difficult to reconcile with ordinarily entertained notions the idea that organisms like bacteria and Torulæ, to say nothing of Moulds, could be products of so-called "spontaneous generation."

Let such critics spend two or three weeks only in examining the developmental changes in the Zooglœas formed in a hay scum, and see how much many other cherished preconceptions will be upset. Are they ever likely to do it? Well, let them bear in mind that three bacteriologists to whom I have demonstrated these changes were unable to doubt that the Fungus-germs, the Monads, and the Amœbæ were actually derived from the ultimate products of segmentation; and, further, that they were unable to suggest "infection" as an hypothesis that could possibly account for the many hundreds of similar changes taking place simultaneously in each fragment containing the different sets of Zooglœa.

When they have seen similar results themselves, what attitude can the critics take? If they see animal products, such as Monads and Amœbæ, taking origin from aggregates of primordial vegetal units like bacteria, and are compelled to recognise that such Monads, altogether independently of any possible inheritance, are enabled to throw out flagella, to come into being provided with a nucleus, and to develop actively functioning contractile vacuoles, will they still adhere to all their preconceptions, or will they rather admit their previous ignorance of nature's potency in this as well as in many other directions?

In a recent able article [5] on "Science and the Limits of Belief," Sir Ray Lankester dwells very forcibly upon "the importance of knowledge based securely on experimental demonstration and the examination of actual things." As he says: "It is precisely by the refusal to discuss possibilities, and by being at the same time willing and anxious to receive and verify tangible demonstration of a fact, however improbable it may appear," that all progress in science has ever been made. With this I absolutely agree; and can only trust that critics generally will adopt a like opinion.

Archebiosis is a process that always takes place beyond our ken, seeing that it must begin with mere molecular collocations, gradually going on to the formation of particles of an ultra-microscopic order. And the only explanation that seems possible of the growth of such particles into organisms like those found in the tubes, as well as of the appearance of the heterogenetic products that we have seen proceeding from Zooglœal segments, is to fall back upon an explanation which is generally admitted to account for all the known forms of crystalline matter. Molecular constitution, combined with the influence of the environment, is what we have to appeal to there; and, as Herbert Spencer over and over again insisted, the forms and structures of organisms, under the influence

[4] As shown by Fig. 4, in NATURE for January 22, 1914.
[5] In the R.P.A. Annual for 1915 (recently published

of what he termed "organic polarity," must be dependent upon like causes. In accounting for the lower forms of living matter, therefore, we may suppose, as he says,[6] that their "organic molecules of each kind, no matter how complex, have a form of equilibrium in which, when they aggregate, their complex forces are balanced."

H. CHARLTON BASTIAN.

SMITHSONIAN GEOLOGICAL EXPLORATIONS.

DURING the past year, the Smithsonian Institution was represented in the field by nineteen parties and individuals engaged in the collection of data relative to astrophysics, geology, biology, and anthropology, besides nine representatives of the Bureau of American Ethnology, who secured information relative to the American Indian. While most of the exploration occurred in the United States, considerable work was carried on in Canada, the West Indies, Peru, Switzerland, Borneo, Cashmere, Egypt, Greece, and Italy.

A recent publication of the institution describing the various explorations, includes a report on the Palæontological field-work of the secretary, Dr. C. D. Walcott, in the Canadian Rockies, near the Robson Peak district in British Columbia and Alberta, and in Field, British Columbia. The mountainous scenery in the former region is quite alpine in appearance, including snow-capped and glacier-covered peaks which tower 7500 to 9800 ft. above Lake Kinney, itself some 3000 ft. above sea-level. On this trip Dr. Walcott's party approached from the west in order to study the invertebrate fossils in this section, which he considers one of the finest in the world. At the base of the mountain at Lake Kinney, there exist fossil beds, 4000 ft. or more in thickness, where a number of important ancient Cambrian fossil fauna were secured, as well as many examples of the species found in 1912. At Field, work was carried on in the great Cambrian fossil quarry, where, after blasting out the solid beds to a depth of 22 ft., a fine collection for the U.S. National Museum was secured.

Another geological research party was also in the field for fossils, but, instead of the very early forms of life sought by Dr. Walcott, this second party, under the direction of Mr. J. W. Gidley, was in search of fossil mammals from a later epoch. In this connection, the party again excavated in the Pleistocene cave deposit near Cumberland, Maryland, discovered in 1912, and found many new forms of mammals, and more complete remains of several species represented in the first collection solely by jaw fragments. The collection now numbers about 300 specimens, which represent forty or more distinct types of hitherto undescribed animals, many of which are now extinct, including the bear, peccary, wolverine, badger, martin, porcupine, woodchuck, dog and the American eland-like antelope. Other specimens found in less complete form were the mastodon, tapir, horse, and beaver, besides several smaller rodents, shrews, and bats. All these different animal remains occur intermingled and comparatively thickly scattered through the deposits of this ancient limestone cave, which was exposed by a cut made by the Western Maryland Railroad, and reported to the museum by Mr. Armbruster. Mr. Gidley is pursuing his studies in identifying these different remains, and expects to continue his excavations from time to time.

Mr. C. W. Gilmore, of the National Museum, conducted explorations in the north-western part of Montana, where some vertebrate fossil bones were discovered by a member of the Geological Survey in 1912. A total of more than 500 separate fossil bones was collected, among them a nearly complete skeleton of a new Ceratopsian or horned dinosaur, the smallest known of the great horned reptiles, and the first to be found having a complete articulated tail and hind-foot. Another find was a partial skeleton of the new Trachodont or duck-billed dinosaur, recently described from specimens obtained in Canada.

Dr. R. S. Bassler spent some time in the Appalachian Valley of Maryland studying the post-Palæozoic geologic history of the region as indicated by the present surface conditions, under the auspices of the U.S. National Museum, and the Maryland Geological Survey.

Another field research party which concerned the collection of fossils was maintained in Illinois by Mr. F. Springer, in connection with the preparation of his monograph on the fossil crinoidea, and to add to the museum collections of these fossil invertebrate marine animals. The field-work was undertaken in co-operation with the geological work of the State of Illinois, in order that the horizons from which these fossils were taken might be definitely determined. This resulted in securing several large cases of material, among which were several very large slabs containing numbers of specimens.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. E. G. FEARNSIDES, Miss F. M. G. Micklethwait, and Dr. E. P. Poulton have been elected to Beit Memorial Fellowships for Medical Research. Each fellowship is of the annual value of 250*l*.

THE third annual conference of educational associations will be held from January 4 to January 9, 1915, at the University of London, South Kensington. The inaugural address on the principles of educational science will be given by Bishop Welldon. In addition to the addresses and discussions in connection with the meetings of the Geographical Association, to which attention was directed in our issue of last week, mention may be made of the following contributions to the conference. At the meeting of the Froebel Society on January 4 Prof. J. J. Findlay will speak on educative toys and apparatus. On January 5 the Rev. Canon Masterman's presidential address to the Teachers' Guild will be on education for national service. The Provisional Committee for the Development of Regional Survey will meet on January 6, and a number of speeches will be delivered on regional survey in relation to education. During the evening of this date the School Nature Study Union will meet, and Mr. E. E. Unwin will speak on nature-study and the teacher. On January 8 the Science Teachers' Association holds its meeting, and Miss Muriel Robertson will speak on some sleeping sickness problems in Uganda; and on the same day Dr. G. R. Parkin will address the Association of Assistant-mistresses on the responsibilities of Empire.

THE annual Convocation of the Allahabad University for conferring degrees was held in November. The Chancellor, Sir James Meston, delivered an address which is reported in the issue of the *Pioneer Mail* for November 20. Towards the end of his remarks he said:—"My sole aim is the greater efficiency of our University. Now there are two kinds of efficiency. One kind, wrongly so called, seeks for a mechanical perfection, an official symmetry, a standardising of work and ideals with little thought

[6] "Principles of Biology" (revised edition, 1898), vol. i., Appendix D, p. 704.

for human weakness and human reticences. Such is the Teutonic form of efficiency, against which the armies of England and India are battling in Europe at this moment. The efficiency which we want in the India of to-day is of a different and a better type. It seeks for a steady improvement of the conditions which stimulate self-development; it does not despise the feelings and frailties of mankind; and it moves through the portals of conviction towards the goal of the ideal. It is in this sense that efficiency must ever be the rally-cry of our University. We can never stand still but must always move forward, striving for the best, with a divine discontent for all the spurious imitations and the makeshifts which we may be asked to accept in its place. In the ordinary life of the world we have constantly to endure the second best or something still poorer, in art, in music, in literature, in our companionships. But let us not foist the second best, if we can help it, on our students. The temptations to be content with it will assail them soon enough. Be it our part to give them the best we can command, and to help them to enjoy and desire it. In this way shall we raise the true efficiency of our University and ensure for our graduates their proper place in the van of Indian progress."

SOCIETIES AND ACADEMIES.

MANCHESTER.

Literary and Philosophical Society, December 1.—Mr. F. Nicholson, president, in the chair.—C. H. **Lander**: Graphical determination of the stresses in the main spars of monoplanes. One of the most complex problems connected with the design of beams continuous over several supports is presented by the main spars of monoplanes. The stresses are made up of direct compressions and those due to bending moments, the determinations of the latter being most complicated. The lift of a wing surface for small angles increases with the angle of incidence and with the square of the velocity: at a speed of about 60 miles per hour the lift of a certain type of curved wing varies from 5 lb. at 4° up to a maximum of 11·7 lb. at 17°; at 120 miles per hour these lifts would be four times as great. Most monoplanes are designed for a load of $0{\cdot}007V^2$lb. per square foot, V being the designed speed in feet per second. From this the loading on the spar may be determined for different angles. The method of solution of the stresses then varies according to the manner in which the lift wires are attached to the spar. The direct application of Claxton Fidler's method of solution of continuous beams may be used when the lift wires are attached to the spar at the neutral axis. When these wires are attached at the lower side of the spar, the longitudinal moments induced may be assumed and their diagrams plotted as though the spars were discontinuous over the points of support, characteristic points obtained, and the true base line drawn by Fidler's method. A modification of Fidler's method can also be used in the case of wires badly adjusted or injured.—Prof. W. H. **Lang**: Studies in the morphology of Isoëtes. Pt. I.—The general morphology of the stock of Isoëtes. The external form and gross anatomy of the two-lobed stock of *Isoëtes lacustris* is described. The upper portion of the stock corresponds to the shoot, the lower portion behaves as a downwardly growing rhizophore, on which roots arise in acropetal succession. The position of the deeply-seated growing line of the rhizophoric region corresponds to that of the secondary meristem of the base of the stem, but its mode of growth is different. The growth proceeds, and the roots are brought to the surface, as if the lower apex were not only drawn out and deeply sunken, but the opposed sides of the depression were congenitally united. When the roots are exposed by the splitting process at the groove they stand exogenously on the surface. This mode of interpreting the morphology of Isoëtes proves satisfactory when applied either to the explanation of the growth of the stock itself or in comparisons with Lepidodendreæ and Pleuromeia. The rhizophoric region of the stock of Isoëtes is regarded as the structure in existing plants most closely comparable to the stigmarian base of the Lepidodendreæ.

December 15.—Mr. F. Nicholson, president, in the chair.—F. R. **Lankshear**: Quantitative absorption spectra. Part ii.—A new ultra-violet photometer. A new ultra-violet photometer was described, in which, by a system of condensers and prisms, two equal beams of light are obtained. One beam passes through the absorbing liquid and the other through a central adjustable sector. Corrections due to the intermittent nature of light thus become unnecessary.—W. C. **Jenkins** and E. L. **Rhead**: Some notes on aerolites: the Appley Bridge aerolite of October 13, 1914. A summary of observations made on the mass found at Appley Bridge, and the results of preliminary analyses of its chemical composition.

PARIS.

Academy of Sciences, December 7.—M. P. Appell in the chair.—Haton de la **Goupillière**: A property of arithmetical progressions.—J. **Bosler** and H. G. **Block**: Observations of the eclipse of the sun of August 21, 1914, made at Strömsund (Sweden) by the expedition from Meudon Observatory. The main object of the expedition was to photograph the spectrum of the corona in the whole visible field, including the red, and, if possible, obtain some indications of its velocity of rotation. The weather conditions proved extremely favourable. The results of the observations are summarised on p. 460.—M. **Skossarewsky**: The electrolytic dissociation of acetylene and its metallic derivatives. The electrolytic dissociation of acetylene and its monosodium derivative has been proved by measurements of conductivity in solution in liquid ammonia. The dissociation increases with the dilution of the solution. The temperature coefficient of the specific conductivity is about 2 per cent. for 1° C., and is nearly independent of the concentration.—M. **Tiffenau**: Molecular transposition in the *cyclo*hexane series: passage to the *cyclo*pentane series. Orthoiodo-hydroxy*cyclo*hexane, treated with silver nitrate, gives the aldehyde of *cyclo*pentane-carboxylic acid. The removal of hydriodic acid causes the opening of the ring, and passing from a *cyclo*hexane to a *cyclo*pentane derivative. Homologues of the *cyclo*hexane alcohol behave in a similar manner.—Marcel Le **Brazidec**: Molecular transposition in the phenyl*cyclo*hexane series: migration of a phenyl group without passage to the *cyclo*pentane series. Iodophenyl*cyclo*hexanol, on elimination of hydriodic acid with silver nitrate gives phenyl*cyclo*hexanone, a *cyclo*pentane derivative not being formed.—C. **Grossmann**: The uranium minerals of Fiadanana, Madagascar. Externally the mineral resembles euxenite and contains from 12 to 40 per cent. of Ur_3O_4. The mineral with the higher proportion of uranium possesses a radio-activity nearly double that of pure black uranium oxide, and may prove a possible source of radium compounds.—Maurice **Lugeon**: Some consequences of the presence of crystalline sheets underlying the Niesen zone (Switzerland).—Fernand **Guéguen**: The alteration termed "piqûre" of sail and tent canvas. The loss of strength of canvas in certain spots after exposure to the open air is shown to be due to the

development in the tissue of various moulds. It does not seem to be due to accidental contamination of the fabric, but is caused by the development, under the influence of moist heat, of filaments of mould present in the new material. Sterilisation by steam is suggested as the most practical means of dealing with the trouble.

BOOKS RECEIVED.

Electrical Engineering in India. By J. W. Meares. Pp. xxxvi+517. (Calcutta: Thacker, Spink and Co.; London: W. Thacker and Co.) 15s.

Preparations and Exercises in Inorganic Chemistry. By W. Lowson. Pp. vii+128. (London: Methuen and Co., Ltd.) 2s. 6d.

Mikrographie des Holzes. By Dr. J. W. Moll and H. H. Janssonius. Vierte Lieferung. Pp. 336. (Leiden: E. J. Brill.)

The Fauna of British India, including Ceylon and Burma. Mollusca II. (Trochomorphidæ—Janellidæ). By G. K. Gude. Pp. xii+520. (London: Taylor and Francis.) 20s.

Memoirs of the Geological Survey, Scotland. The Geology of Caithness. By C. B. Crampton and R. G. Carruthers. Pp. viii+194. Sheets 110 and 116, to accompany the foregoing. (London: H.M.S.O.; E. Stanford, Ltd.) 4s.

Magnetism and Electricity, including the Principles of Electrical Measurements. By S. S. Richardson. New edition. Pp. ix+598. (London: Blackie and Son, Ltd.) 4s. 6d.

Pottery, for Artists, Craftsmen, and Teachers. By G. J. Cox. Pp. ix+200. (London: Macmillan and Co., Ltd.) 5s. 6d. net.

Canada. Department of Mines. Geological Survey. Memoir 41. The "Fern Ledges" Carboniferous Flora of St. John, New Brunswick. By M. C. Stopes. Pp. vi+142+xxv plates. Memoir 54. Annotated List of Flowering Plants and Ferns of Point Pelee, Ont., and Neighbouring Districts. By C. K. Dodge. Pp. 131. Mines Branch. Lode Mining in Yukon. By T. A. MacLean. Pp. ix+205. The Copper Smelting Industries of Canada. By Dr. A. W. G. Wilson. Pp. xiv+184+plates. (Ottawa: Government Printing Bureau.)

The Rare Earths: their Occurrence, Chemistry, and Technology. By S. I. Levy. Pp. xiv+345. (London: Edward Arnold.) 10s. 6d. net.

Numerical Trigonometry. By N. J. Chignell. Pp. 126+xii. (Oxford: Clarendon Press.) 2s. 6d.

The Principles and Practice of Judging Live-Stock. By Prof. C. W. Gay. Pp. xviii+413. (London: Macmillan and Co., Ltd.) 6s. 6d. net.

The Chemistry of Cyanogen Compounds and their Manufacture and Estimation. By H. E. Williams. Pp. viii+423. (London: J. and A. Churchill.) 10s. 6d. net.

Huxley Memorial Lectures to the University of Birmingham. With an Introduction by Sir Oliver Lodge. Pp. 157. (Birmingham: Cornish Bros., Ltd.) 5s. net.

Hazell's Annual for 1915. Edited by T. A. Ingram. Pp. 592. (London: Hazell, Watson, and Viney, Ltd.) 3s. 6d. net.

The Chemistry of the Radio-Elements. By Prof. F. Soddy. Part i. Second edition. Pp. viii+151. (London: Longmans and Co.) 4s. net.

Catalogue of the Lepidoptera Phalænæ in the British Museum. Supplement, vol. i. Catalogue of the Amatidæ and Arctiadæ (Nolinæ and Lithosianæ) in the Collection of the British Museum. By Sir George F. Hampson. Pp. xxviii+858. (London: Longmans and Co., and others.) 25s.

The Pupil's Class-Book of Geography: The British Dominions. By E. J. S. Lay. Pp. 128. (London: Macmillan and Co., Ltd.) 6d.

First Book of Physiology and Hygiene. By G. D. Cathcart. Pp. vi+158. (London: Macmillan and Co., Ltd.) 1s. 6d.

Scottish National Antarctic Expedition. Ornithology of the Scottish National Antarctic Expedition. By W. E. Clarke, Dr. R. N. R. Brown, and L. N. G. Ramsay. Pp. 203–306+vii plates. The Seals of the Weddell Sea: Notes on their Habits and Distribution. By Dr. R. N. R. Brown. Pp. 185–198+ix plates. (Edinburgh: Scottish Oceanographical Laboratory.) 11s. and 3s. 6d. respectively.

Science and Religion. By Seven Men of Science, speakers in Browning Hall during Science Week, 1914. Pp. 138. (London: W. A. Hammond.) 1s. net.

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